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PAGE'S WEEKLY

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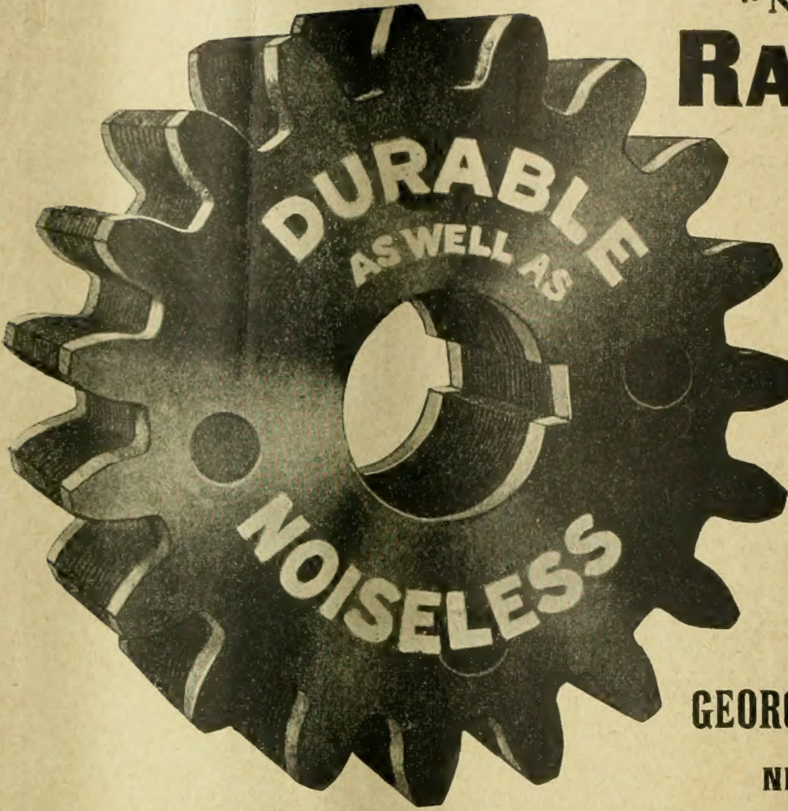

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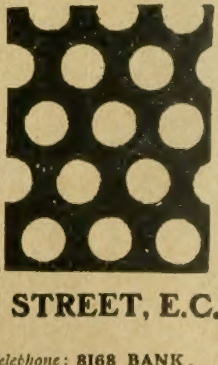

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VOLUME VII.

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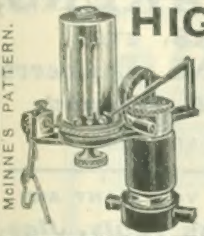

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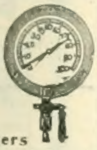

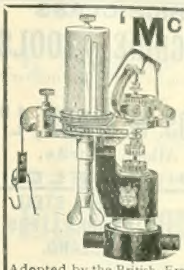

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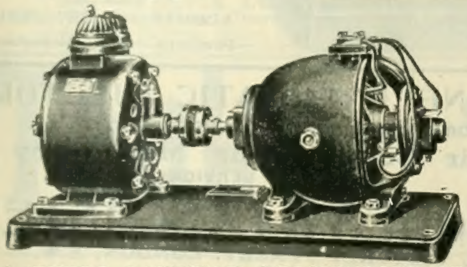

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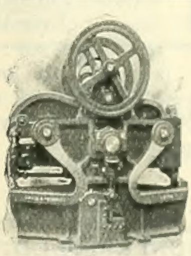

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Tenders are to be delivered, under seal, to me at the Council Offices, on or before Friday, January 5th, 1906.

JOSEPH EVEREST,
Clerk to the Council.

Council Offices, St. John's Hill, Shrewsbury,
December 16th, 1905.

MANCHESTER CORPORATION GAS DEPARTMENT.

TO IRON AND STEEL WORK CONTRACTORS.

The Gas Committee are prepared to receive **TENDERS** for the IRON and STEEL WORK required in the **SUPPLY** and **ERECTION** of FOUR PURIFIERS, &c., &c., at the Gaythorn Station.

Specification and Bill of Quantities can be obtained from Mr. C. NICKSON, Superintendent, Gas Department, Town Hall, on payment of Two Guineas, which will be returned on receipt of a *bona fide* Tender.

Drawings may be seen, and any other information required may be had, on application to Mr. J. G. NEWBIGGING, M.Inst.C.E., at his office, Rochdale Road Station.

Sealed Tenders, addressed to the Chairman of the Gas Committee and endorsed "Tender for Purifiers, Gaythorn Station," must be delivered at the Gas Offices, Town Hall, not later than 9 a.m. on Friday, January 5th, 1906.

The Committee do not bind themselves to accept the lowest or any Tender.

WM. HENRY TALBOT,
Town Clerk.

Town Hall, Manchester,
December 15th, 1905.

COUNTY BOROUGH OF GRIMSBY.

ELECTRICITY DEPARTMENT.

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,, No. 39.—**Buildings—Bills of Quantities for Extension of Engine-room, New Coal Bunkers, and New Store.**
,, No. 43.—**Pipework.**
,, No. 44.—**Coal-Conveying Plant—Two Scraper Conveyors and One Elevator.**
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Copies of the respective Specifications, **General Conditions**, and **Drawings (if any) can be obtained from the undersigned on payment of a deposit of One Guinea on each Specification, which will be returned upon receipt of a *bona fide* Tender. Extra copies of the Specifications may be purchased at 2s. 6d. each, except** Specification **No. 39—Bill of Quantities, which may be purchased at 5s. each ; extra copies of Drawings 2s. 6d. each.**

Tenders, on the prescribed form, in sealed envelopes, must be delivered to the undersigned not later than the first post, Friday, January 5th, 1906.

W. A. VIGNOLES,
Borough Electrical Engineer.

Corporation Electricity Works, Grimsby,
December 7th, 1905.

OAKENGATES URBAN DISTRICT COUNCIL.

WATERWORKS.

TO CONTRACTORS AND IRONFOUNDERS.

The above Council is prepared to receive **TENDERS** from competent persons for the PROVISION and **LAYING** of **CAST IRON** and other MAINS.

The Drawing may be seen and copies of the Specification, Bill of Quantities, and form of Tender, may be obtained at the office of the Engineers, Messrs. R. E. W. BERRINGTON AND SON, Bank Buildings, Wolverhampton, on and after Wednesday, December 20th, upon payment of Five Guineas, which will only be returned upon the receipt of a *bona fide* Tender.

Sealed Tenders, addressed to me, endorsed "**Tender for Waterworks**," must be delivered at my office before noon on Saturday, January 20th, 1906.

The Council does not bind itself to accept the lowest or any Tender.

JNO. A. HOLMES, Solicitor,
Oakengates, December 13th, 1905. Clerk to the Council.

CORPORATION OF DURBAN, NATAL.

WATERWORKS EXTENSION.

TENDERS FOR 30-in STEEL PIPES.

The Corporation of Durban, Natal, is prepared to receive TENDERS for the SUPPLY and DELIVERY, "free on board" (and alternately for delivery c.i.f., Durban) of six miles of 30-in. MILD STEEL PIPES, weighing approximately 1,500 tons. Three miles to be delivered at Durban not later than June 30th, 1906, and the remaining three miles to be delivered not later than November 30th, 1906.

General Conditions, Specification, and Bill of Quantities, with form of Tender, can be obtained from Mr. W. H. RADFORD, C.E., Albion Chambers, Nottingham, Consulting and Representative Engineer to the Corporation, on deposit of Three Guineas, which will be returned on receipt of a *bona fide* Tender.

Scaled and endorsed Tenders must be delivered to the undersigned, Agents to the Durban Corporation, on or before Monday, January 15th, 1906.

The lowest or any Tender will not necessarily be accepted.

By order,
WEBSTER, STEEL, AND CO.,
Agents to the Durban Corporation.

5, East India Avenue, Leadenhall Street, London, E.C.,
December 16th, 1905.

CITY OF LAUNCESTON, TASMANIA.

ELECTRIC LIGHT DEPARTMENT.

TENDERS FOR SUPPLY OF METERS.

The MAYOR and ALDERMEN of the City of Launceston, Tasmania, are prepared to receive TENDERS for the SUPPLY of 500 or more ELECTRIC METERS and for MAXIMUM DEMAND INDICATORS.

Specifications and Conditions of Contract in duplicate may be obtained on application to Mr. WILLIAM CORIN, City Electrical Engineer, Launceston, Tasmania, or to Messrs. JOHN TERRY AND CO., 7, Great Winchester Street, London, E.C., England, on payment of Two Guineas, which sum will be refunded on receipt of a *bona fide* Tender.

Sealed Tenders, endorsed "Tenders for Supply of Electric Meters," must be addressed to the undersigned and lodged in his office not later than 12 o clock noon of Monday, the 15th day of January, 1906.

C. W. ROCHER,
Town Clerk.

Town Hall, Launceston, Tasmania,
September 25th, 1905.

COUNTY OF LONDON.—TO STEEL RAIL MANUFACTURERS, ENGINEERS, AND OTHERS.

The London County Council invites **TENDERS** for the SUPPLY and DELIVERY of about 2,300 **TONS** of **STEEL SLOT RAILS** required in connection with the reconstruction, for electrical traction on the conduit system, of certain of the Council's tramways north of the Thames.

Persons desiring to submit Tenders may, on and after Monday, December 18th, 1905, obtain the Specification, Bill of Quantities, form of Tender, and other particulars, on application to the Engineer's Department, County Hall, Spring Gardens, S.W., upon payment to the Cashier of the Council of the sum of £2.

This amount will, after the Council or its Committee shall have come to a decision upon the Tenders received, but not before, be returned to the Tenderer, provided he shall have sent in a *bona fide* Tender and shall not have withdrawn the same, but in no case will the fee be returned unless a *bona fide* Tender is submitted.

Full particulars of the work may be obtained on application at the County Hall previously to the payment of the fee for the Specification, &c.

Each Tender must be upon the official form, and the printed instructions contained therein, must be strictly complied with.

The contractors will be bound by the contract to pay to all workmen for work executed under the contract wages at the rates arranged between the employers and workmen in the rail trade in that part of the country where the order is placed.

Each Tender is to be delivered at the County Hall, in a sealed cover, addressed to the "Clerk of the London County Council, Spring Gardens, S.W.," and marked "Tender for Slot Rails, L.C.C. Tramways."

No Tender will be received after Ten o'clock a.m. on Tuesday, January 16th, 1906.

Any Tender which does not comply with the printed instructions for Tender may be rejected.

The Council does not bind itself to accept the lowest or any Tender and it will not accept the Tender of any person or firm who shall on any previous occasion have withdrawn a Tender after the same had been opened, unless the reasons for withdrawal were satisfactory to the Council.

G. L. GOMME,
County Hall, Clerk of the London County Council.
Spring Gardens, S.W.,
December 15th, 1905.

PAGE'S WEEKLY Contracts and Appointments Open

CROMPTON URBAN DISTRICT COUNCIL.

The Crompton Urban District Council solicit Tenders for the following:—

(1) SLUDGE-PRESSING MACHINERY.

(2) GAS ENGINE to give 25 brake horse-power when worked with producer gas, also necessary GAS-PRODUCER PLANT for working same.

The prices in each case to include delivery and erection at Council's Newhey Sewage Works.

Further particulars may be obtained on application to Mr. T. MITCHELL, F.G.S., Sewage Works Superintendent, Shaw.

Tenders, sealed and endorsed "Sludge-pressing Machinery," or "Gas Engine and Producer," as the case may be, must be delivered to me on or before Monday, January 8th, 1906.

Town Hall, Shaw, F. F. GARTSIDE,
December 13th, 1905. Clerk to the Council.

TO WELL-BORERS AND CONTRACTORS.

The PARISH COUNCIL of BOCKING, near Braintree, Essex, invite TENDERS for SINKING a BOREHOLE and LINING same with STEEL TUBES for the purpose of obtaining a Supply of Water for the said Parish.

Specification and Schedule of proposed works may be obtained from the Engineer, Mr. E. H. BRIGHT, Dodds Hall, Braintree.

The Council do not bind themselves to accept the lowest or any Tender.

Tenders to be marked "Water Supply, Bocking," and delivered to Mr. G. ELGER, Clerk to the Bocking Parish Council, Bradford Street, Bocking, on or before the 30th day of December, 1905.

The accepted Contractor for this work will have to find a guarantee bond for £200 from an office approved by the above Council.

NORTH-EASTERN RAILWAY.—TO CONTRACTORS.

—The Directors are prepared to receive TENDERS for the WORKS required in connection with the RECONSTRUCTION of No. 4 GRAVING DOCK, West Hartlepool. Plans may be seen, and copies of the Specification and Quantities obtained, on personal application only to Mr. T. M. NEWELL, Engineer, Dock Office, Hull, on and after December 13th, 1905. Sealed Tenders, marked "Tender for No. 4 Graving Dock, West Hartlepool," to be delivered at the Secretary's Office, York, not later than 12 noon on Wednesday, January 10th, 1906. The Company do not bind themselves to accept the lowest or any Tender.

York, December 4th, 1905. R. F. DUNNELL, Secretary.

NEWPORT (MON.) GAS COMPANY.

The Directors of the Newport (Mon.) Gas Company are prepared to receive TENDERS for the WORKS hereinafter described to be carried out at their Crindau Gasworks, Newport (Mon.), viz.:—

Contract No. 1.—Extension of existing Retort House, Raising Walls of Building and Roof, Construction of Siding, and Alteration of existing Sidings.

Contract No. 2.—Construction of Regenerative Retort Settings (Horizontal) of 216 Mouthpieces, with all Mains, Fittings, Stage Floor, Coal-handling Plant, comprising coal breaker, elevator, conveyor, hoppers, wagon-tipping travelling crane, capstans, and motors.

Contract No. 3.—Coke-handling Plant, comprising Telpher system, coke trams, and narrow-gauge railway.

Contract No. 4.—Gas Engines and Plant for Generating and Distributing Power on Works.

Contract No. 5.—A Set of Six Purifiers, with Valves, Connections and Shed.

Drawings and Specifications may be seen on application to Mr. THOMAS CANNING, A.M.Inst.C.E., the Engineer, Gasworks, Mill Street, Newport (Mon.), on and after the 11th day of December, 1905, and copies of the Specification, Schedule, and Form of Tender can be obtained on receipt by the undersigned of Five Guineas, which will be returned when a *bona fide* Tender is received.

Tenders, addressed to the Chairman of the Company, to be lodged with the undersigned on or before Wednesday, January 3rd, 1906, sealed and endorsed as directed under the Specifications for each portion of the works.

The Directors do not bind themselves to accept the lowest or any Tender.

Gas Offices, Mill Street, Newport (Mon.), T. H. HAZELL,
November 30th, 1905. Secretary.

ADMINISTRATIVE COUNTY OF LONDONDERRY.

The County Council of the above-named County invite TENDERS, which must be lodged with me on or before Thursday, January 18th, 1906, for the SUPPLY and DELIVERY of:—

ONE STEAM ROAD ROLLER.
ONE ROAD SLEEPING VAN.
ONE WATER CART.

Specifications for the articles required may be seen, or copies obtained, at the office of the County Surveyor, County Courthouse, Londonderry.

Dated this 8th day of December, 1905.

THOMPSON B. ADAMS,
County Courthouse, Londonderry. Secretary to County Council.

APPOINTMENTS OPEN.

TWICKENHAM URBAN DISTRICT COUNCIL.

1. ROAD FOREMAN.
2. BUILDING AND DRAINAGE INSPECTOR.

The Twickenham Urban District Council invite application for the following APPOINTMENTS:—

1. Road Foreman.—Candidates, whose age must not exceed 40 years, must have had a thorough practical experience in work of a similar nature, must be competent to superintend, under the direction of the Surveyor, all manual and team labour employed by the Council, to set out and supervise all street and sewer works, and to furnish accurate returns of all labour and materials in connection therewith. Salary, £3 per week.

2. Building and Drainage Inspector.—Candidates, whose age must not exceed 40 years, must possess a thorough practical knowledge of building construction and drainage work, and be well acquainted with the requirements of the model bye-laws of the Local Government Board relating thereto. Salary, £2 15s. per week.

Applications for either appointment on forms to be obtained at the Surveyor's Office, to be delivered to Mr. FRED W. PEARCE, Surveyor to the Council, Town Hall, Twickenham, endorsed "Road Foreman" or "Building and Drainage Inspector," as the case may be, not later than Monday, the 1st day of January, 1906.

Canvassing the members of the Council in any way is prohibited, and will disqualify any candidate.

By order,
H. JASON SAUNDERS,
Clerk to the Council.

Town Hall, Twickenham,
December 15th, 1905.

CITY OF BRADFORD.—THE CORPORATION

invite APPLICATIONS for the appointment of THREE ENGINEERING ASSISTANTS in the Sewage Works, Engineer's Department, at a salary of £150 per annum each.

Candidates must have had actual experience in the designing and construction of large sewers and works of sewage disposal. Age not to exceed 35.

Applications endorsed "Engineering Assistant," stating age and experience, must be accompanied by copies of two testimonials of recent date, and addressed to me at the Town Hall, Bradford, before January 16th, 1906.

FREDERICK STEVENS,
Town Clerk.

AN "INSTITUTION OF NAVAL ARCHITECTS" SCHOLARSHIP,

of the annual value of £50, and, subject to certain conditions, tenable for three years, will be OFFERED for COMPETITION by the Council of the above Institution.

Candidates must, at the time of the examination, be students of the Institution, and not less than eighteen or more than twenty-one years of age on March 1st, 1906, and must at that date have been continuously employed for two years upon Naval Architecture or Marine Engineering.

Further particulars and forms of entry and conditions regulating the admission of students, may be obtained from the Secretary, Institution of Naval Architects, 5, Adelphi Terrace, London, W.C.

Applications must be sent in by February 1st, 1906.

CIVIL SERVICE COMMISSION.

FORTHCOMING EXAMINATION.
SECOND-CLASS ENGINEERS, ENGINEER-IN-CHIEF'S DEPARTMENT, GENERAL POST OFFICE (22-24).
JANUARY 11TH, 1906.

The date specified is the latest at which applications can be received.

They must be made on forms to be obtained, with particulars, from the Secretary, Civil Service Commission, Burlington Gardens, London, W.

NOTICE TO MARINE ENGINEERS.

The Arklow Harbour Commissioners require the SERVICES of an ENGINEER to prepare plans for the Extension of the South Breakwater, and to superintend the carrying out of same. Such plans to meet the approval of the Harbour Commissioners and the sanction of the Lord-Lieutenant.

Parties applying for the position must satisfy the Board that their appointment will have the approval of the Lord-Lieutenant.

Applications to be sent, stating fees, &c., to the Secretary, Harbour Commissioners, before January 9th, 1906.

CITY OF AUCKLAND, NEW ZEALAND.

APPOINTMENT OF CITY ENGINEER.

Applications, accompanied by Testimonials, will be received in the Town Clerk's Office, Auckland, New Zealand, until 4 o'clock p.m. on Thursday, February 8th, 1906, for the appointment of City Engineer to the City of Auckland. Conditions of appointment may be seen, and copies obtained, at the office of the High Commissioner for New Zealand, Westminster Chambers, 13, Victoria Street, London, S.W.

HENRY W. WILSON,
September 1st, 1905 Town Clerk.

BUYERS' DIRECTORY.

NOTE.—*The display advertisements of the firms mentioned under each heading can be found readily by reference to the Alphabetical Index to Advertisers on pages 22 and 24.*

In order to assure fair treatment to advertisers, each firm is indexed under its leading speciality ONLY.

Advertisers who prefer, however, to be entered under two or more different sections can do so by an annual payment of 5s. for each additional section.

Advertisers' Service Bureau.
British Advertiser Service Bureau, Queen Anne's Chambers Westminster, S.W.

Artesian Well Machinery.
John Z. Thom, Patricroft, Manchester.

Band Sawing Machines.
Noble & Lund, Ltd., Felling-on-Tyne.

Bearings (Roller).
Hyatt Roller Bearing Co., 47, Victoria Street, London S.W.

Belting.
Binney & Son, Catherine Street, City Road, London, E.C.
Cort, Arthur, & Co., Camberwell, London, S.E.
Fleming, Birkby & Goodall, Ltd., West Grove, Halifax.
Gilmour, W. & O., St. John's Hill, Edinburgh.

Boilers.
Clayton, Son & Co., Ltd., Leeds City Boiler Works, Leeds.
Grantham Boiler and Crank Co., Ltd., Grantham.
Hartley & Sugden, Ltd., Halifax.
Thompson, John, Wolverhampton.

Boilers (Water-tube).
Babcock & Wilcox, Ltd., Oriel House, Farringdon Street, London, E.C.
Stirling Boiler Co., Ltd., Motherwell, N.B.

Bolts, Nuts, Rivets, etc.
Herbert W. Periam, Ltd., Floodgate Street Works, Birmingham.
T. D. Robinson & Co., Ltd., Derby.

Books.
Griffin, Charles, & Co., Exeter Street, Strand, W.C.
New Zealand Mines Record, Wellington, New Zealand.
Spon, E. & F. N., 125, Strand, W.C.

Boring Machines.
Asquith, William, Ltd., Well Road Works, Halifax.
Niles-Bement-Pond Co., 23-25, Victoria Street, London, S.W.
Noble & Lund, Ltd., Felling-on-Tyne.

Cables.
Callender's Cable and Construction Co., Ltd.

Case-Hardening Compounds.
Hy. Miller & Co., Millgarth Works, Leeds.

Castings.
Ashmore, Benson, Pease & Co., Ltd., Stockton-on-Tees.

Catalogues, Printing, &c.
Atlantic Press, Ltd., Weymouth Street, Manchester.
Spottiswoode Advertising Agency, Clun House, Surrey Street, Strand, W.C.
Stafford, Arthur, & Co., Denton, Manchester.

Chucks.
Fairbanks Co., 78-80, City Road, London, E.C.

Cisterns, Tanks, &c.
Ashmore, Benson, Pease & Co., Ltd., Stockton-on-Tees.
F. A. Keep, Juxon & Co., Barn Street, Birmingham.

Clutches (Friction).
David Bridge & Co., Castleton Ironworks, Rochdale, Lancashire.

Coke Oven Expert.
Mallmann, P. J., 110-118, Victoria Street, S.W.

Condensing Plant.
Benn, Sykes, Haslingden, near Manchester.
Concentric Condenser, Ltd., 23, Northumberland Avenue, London, W.C.
Mirrlees-Watson & Co., Ltd., Glasgow.

Consulting Engineers.
Gibbs, John, & Son, 80, Juke Street, Liverpool.
G. H. Hughes, A.M.I.M.E., 19, Old Queen Street, Westminster, S.W.
Melville & Macalpine, 615, Walnut Street, Philadelphia, Pa., U.S.A.
Mount-Haes, A., M.I.Mech.E., M.I.M.E., 11, Ironmonger Lane, London, E.C.

Continental Railway Arrangements.
Northern Railway of France.
South Eastern & Chatham Railway Co.

Conveying and Elevating Machinery.
Adolf Bleichert & Co., Leipzig-Gohlis, Germany.
Fraser & Chalmers, Ltd., 3, London Wall Buildings, London, E.C.
Temperley Transporter Co., 72, Bishopsgate Street Within, London, E.C.

Copper and Brass.
W. Hepton & Son, Hunslet Lane, Leeds.

Coverings (Boiler).
Magnesia Covering Ltd., Washington Station, co. Durham.

Cranes, Travellers, Winches, etc.
Joseph Booth & Bros. Ltd, Rodley, Leeds.
Thomas Broadbent & Sons, Ltd., Huddersfield.
Niles-Bement-Pond Co., 23-25, Victoria Street, London, S.W.

Cranks.
Clarke's Crank & Forge Co., Ltd., Lincoln, England.

Cutters (Milling).
Pratt & Whitney Co., 23-25, Victoria Street, London, S.W.
E. G. Wrigley & Co., Ltd., Foundry Lane Works, Soho, Birmingham.

Destructors.
Heenan & Froude, 4, Chapel Walks, Manchester.
Horsfall Destructor Co., Ltd., Armley, Leeds.

Dredges and Excavators.
Delange & Cie, Mce., Hoboken, near Antwerp.
Rose, Downs & Thompson, Ltd., Old Foundry, Hull.

Drilling Machines.
Asquith, William, Ltd., Well Road Works, Halifax.
Niles-Bement-Pond Co., 23-25, Victoria Street London, S.W.
Noble & Lund, Ltd., Felling-on-Tyne.
Swift, George, Clarence Ironworks, Halifax.

Economisers.
E. Green & Son, Ltd., Manchester.

Ejectors (Pneumatic).
Hughes & Lancaster, 16, Victoria Street, London, S.W.

Electrical Apparatus.
Allgemeine Elektricitäts Gesellschaft, Berlin, Germany.
British Westinghouse Electric and Manufacturing Co., Ltd., Norfolk Street, Strand, London, W.C.
Broadbent, T. W., Victoria Electrical Works, Huddersfield.
Crypto Electrical Co., 3, Tyer's Gateway, Bermondsey Street, London, S.E.
Ebonestos Manufacturing Co., 22, Rosoman Street, London, E.C.
Gent & Co., Ltd., Faraday Works, Leicester.
Greenwood & Batley, Ltd., Albion Works, Leeds.
India Rubber, Gutta Percha, and Telegraph Works Co., Ltd., Silvertown, London, E.
Matthews & Yates, Ltd., Swinton, Manchester.
Mix and Genest, Berlin, W., Germany.
Nalder Bros. & Thompson, 34, Queen Street, London, E.C.
New Gutta Percha Co., Ltd., Dashwood House, New Broad Street, E.C.
Newton Brothers, Full Street, Derby.
Phœnix Dynamo Manufacturing Co., Bradford, Yorks.
Scott, E., & Mountain, Ltd., Newcastle-on-Tyne.
Sturtevant Engineering Co., Ltd., 147, Queen Victoria Street, London, E.C.
Turner, Atherton & Co., Ltd., Denton, Manchester.
B. Weaver & Co. (*see* Ebonestos Manufacturing Co.), 22, Rosoman Street, Clerkenwell, London, E.C.

Engineers' Supplies.
Ahlers, Ad., Whitley Bay, near Newcastle-on-Tyne.

Engines (Gas).
Campbell Gas Engine Co., Ltd., Halifax.
Cundall, Son & Co., Ltd., Airedale Iron Works, Shipley.

Engines (Electric Lighting).
McLaren, J. and H., Midland Engine Works, Leeds.

Engines (Locomotive).
Baldwin Locomotive Works, Philadelphia, Pa., U.S.A.
Hunslet Engine Co., Ltd., Leeds, England.
Hudswell, Clarke & Co., Ltd., Leeds, England.
McLaren, J. & H., Midland Engine Works, Leeds.

Engines (Stationary).
Allis-Chalmers Co., 533, Salisbury House, Finsbury Circus, London, E.C.
Fraser & Chalmers, Ltd., 3, London Wall Buildings, London, E.C.
Mirrlees Watson Co., Ltd., Glasgow.

Engines (Traction).
Jno. Fowler & Co. (Leeds), Ltd., Steam Plough Works, Leeds.

Engravers.
Jno. Swain & Son, Ltd., 58, Farringdon Street, London, E.C.

Exhaust Steam Oil Separators.
Lancaster & Tonge, Ltd., Pendleton, Manchester.

Fans, Blowers.
Capel Fan Co., 13, Moseley Street, Newcastle-on-Tyne.
Davidson & Co., Ltd., "Sirocco" Engineering Works, Belfast, Ireland.
Gibbs, John & Son, 80, Juke Street, Liverpool.
Matthews & Yates, Ltd., Swinton, Manchester.

Files.
Flockton, Tompkin & Co., Ltd., Newhall Steel Works, Sheffield.

Fire Bricks.
J. H. Sankey & Son, Ltd., Essex Wharf, Canning Town, London, E.

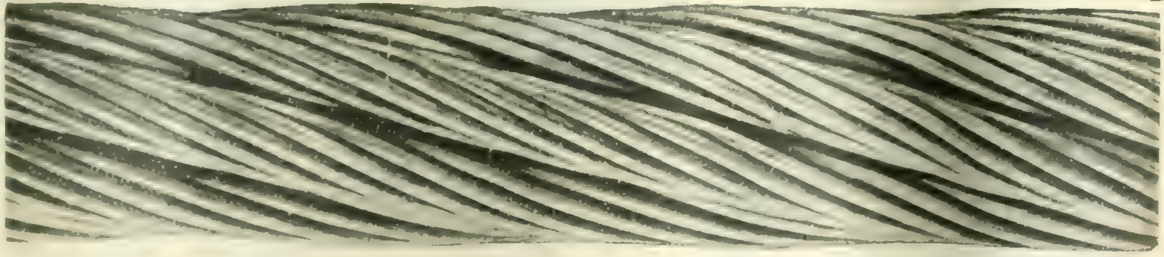
RESULT OF A TEST

OF ONE OF

BULLIVANTS' STEEL WIRE ROPES

AFTER WORKING 3¾ YEARS.

This rope WHEN NEW measured 5¼ in. circ. and took a breaking strain of 104 TONS. SAME ROPE (STILL IN USE) after working continuously for 3¾ YEARS hauling heavy trains up an incline of 1 in 12, during which time it ran 58,000 MILES, and had reduced in size to 4[illegible] in. circ., WHEN TESTED took a breaking strain of 85 TONS 17 CWT.



WIRE ROPES FOR CRANES, LIFTS, HOISTS, DERRICKS, AND ALL PURPOSES.

BULLIVANT & CO., LTD.,

REGD. OFFICE: 72, Mark Lane, London. WORKS: Millwall, E.

Buyers' Directory—(*Continued*).

Firewood Machinery.
M. Glover & Co., Patentees and Saw Mill Engineers, Leeds

Fountain Pens.
Mabie, Todd & Bard, 93, Cheapside, London E.C.

Forging (Drop) Plants.
Brett's Patent Lifter Co., Ltd., Coventry.

Forgings (Drop).
J. H. Williams & Co., Brooklyn New York, U.S.A

Furnaces.
Deighton's Patent Flue & Tube Company, Vulcan Works, Pepper Road, Leeds.
Leeds Forge Co., Ltd., Leeds.

Gauge Glasses.
J. B. Treasure & Co., Vauxhall Road, Liverpool.
T[illegible], J. & Sons, Aston, Birmingham.

Gauges (Pressure, Vacuum, and Hydraulic).
Dobbie McInnes, Ltd., 45, Bothwell Street, Glasgow

Gearing.
Ahlers, Ad., Whitley Bay, near Newcastle-on-Tyne.
Angus, G., & Co., Ltd., Newcastle-on-Tyne.
Asquith, William, Ltd., Well Road Works, Halifax.
[illegible] W[illegible], Percival Street, C-on-M., Manchester
[illegible] near Glasgow.
Wild, M. B., & Co., Corporation Street, Birmingham.

Gold Dredging Plant.
Fraser & Chalmers, Ltd., 3, London Wall Buildings, London, E.C.

Greases.
Blumann and Stern, Ltd., Plough Bridge, Deptford, London, S.E.

Hack Saws.
[illegible] Knuzden Brook, Blackburn.

Hammers (Steam).
Davis & Primrose, Leith Ironworks, Edinburgh.
Niles-Bement Pond Co., 23-25, Victoria Street, London, S.W

Hoisting Machinery.
See Conveying Machinery.

Horizontal Boring Machines.
Asquith, William, Ltd., Well Road Works, Halifax.
Greenwood & Batley, Albion Works, Leeds.
Niles-Bement-Pond Co., 23-25, Victoria Street, London, S.W.
Noble & Lund, Ltd., Felling-on-Tyne.
Swift, George, Clarence Ironworks, Halifax.

Hydraulic Leather.
Ahlers, Ad., Whitley Bay, near Newcastle-on-Tyne.

Hydraulic Machine Tools.
Niles-Bement-Pond Co., 23-25, Victoria Street, London, S.W.
Vauxhall and West Hydraulic Engineering Co. Ltd., 23, College Hill, London, E.C.

Icemaking and Refrigerating Machinery.
H. J. West & Co., 114-118, Southwark Bridge Road, London, S.E.

Indicators.
Dobbie McInnes, Ltd., 45, Bothwell Street, Glasgow.
Hannan & Buchanan, 75, Robertson Street, Glasgow.

Iron and Steel.
Allen, Edgar, & Co. Ltd., Imperial Steel Works, Sheffield.
A[illegible] & W[illegible]son, Ltd., Sheffield
Buckley, Saml., St. Paul's Square, Birmingham.
F[illegible], Old Mint, Shadwell Street, Birmingham.
Farnley Iron Co., Ltd., Leeds England
Flockton, Tompkin & Co., Ltd., Newhall Steel Works, Sheffield.
Fried. Krupp Grusonwerk, Magdeburg Buckau, Germany
J. Frederick Melling, 14, Park Row, Leeds, England.
Parker Foundry Co., Derby.
Purden, John & Sons, Lambhill Forge, by Maryhill, Glasgow.
Walter Scott, Ltd., Leeds Steel Works, Leeds, England.

Ironwork (Constructional).
F. A. Keep, Juxon & Co., Barn Street, Birmingham.

Ironwork (Galvanised).
F. A. Keep, Juxon & Co., Barn Street, Birmingham.

Lagging Sheets.
[illegible] Lime Street, London, E.C.

Lathes.
Asquith, William, Ltd., Well Road Works, Halifax.
Bradbury & Co., Ltd., Wellington Works, Oldham.
Eclipse Tool Manufacturing Co., Linwood, near Glasgow.
Leckenby, Benton, & Co., Perseverance Ironworks, Halifax.
Mitchell, D., & Co., Ltd., Parsonage Works, Keighley.
Niles-Bement-Pond Co., 23-25, Victoria Street, London, S.W.
Noble & Lund, Ltd., Felling-on-Tyne.
Northern Engineering Co., 1900, Ltd., King Cross, near Halifax
Swift, George, Clarence Ironworks, Halifax

Lathe Carriers
Williams, J. H., & Co., Brooklyn New York, U.S.A

Laundry Machinery.
[illegible] Summerscales & Sons, Ltd., Engineers, Phœnix Foundry, Keighley, England.

Lifts.
Waygood & Co., Ltd., Falmouth Road, London, S.E.

Lubricants.
Blumann & Stern, Ltd., Plough Bridge, Deptford, London, S.E.
Reliance Lubricating Oil Co., The, 19 & 20, Water Lane, Great Tower Street, London, E.C.
Matthew Wells & Co., Hardman Street Oil Works, Manchester.

Machine Tools.
Asquith, William, Ltd., Well Road Works, Halifax.
George Addy & Co., Waverley Works, Sheffield.
Bateman's Machine Tool Co., Hunslet, Leeds.
[illegible]and, Perkin, & Co., School Close Works, Leeds.
Bertrams, Ltd., St. Katherine's Works, Sciennes, Edinburgh.
Bradbury & Co., Ltd., Wellington Works, Oldham.
Breuer, Schumacher & Co., Ltd., Kalk, near Cologne-on-Rhine (Germany).
Consolidated Pneumatic Tool Co., Ltd., Palace Chambers, [illegible] Bridge Street, Westminster, S.W.
Cunliffe & Croom, Ltd., Broughton Ironworks, Manchester.
Dean, Smith & Grace, Ltd., Keighley.
Dempster, Moore & Co., Ltd., 49, Robertson Street, Glasgow.
Fengl, A., & Co., Grafton Street, Altrincham.
Greenwood & Batley, Ltd., Leeds.
Jones & Lamson Machine Co., 97, Queen Victoria Street, London, E.C.
John Lang & Sons, Johnstone, near Glasgow.
Luke & Spencer, Ltd., Broadheath, Manchester.
Jos. C. Nicholson Tool Co., City Rd. Tool Wks., Newcastle-on-Tyne.
Niles-Bement-Pond Co., 23-25, Victoria Street, London, S.W.
Noble & Lund. Ltd., Felling-on-Tyne.
Northern Engineering Co., 1900, Ltd., King Cross, near Halifax
J. Parkinson & Son, Canal Ironworks, Shipley, Yorkshire.
C. Redman & Sons, Halifax.
Resides, 12, Aire Street, Brighouse, Yorks.
Rice & Co. (Leeds), Ltd., Leeds, England.
G. F. Smith, Ltd., South Parade, Halifax.
Swift, George, Clarence Ironworks, Halifax.
Taylor and Challen, Ltd., Derwent Foundry, Constitution Hill, Birmingham.
Vauxhall and West Hydraulic Engineering Co., Ltd., 23, College Hill, London, E.C.
H. W. Ward & Co., Lionel Street, Birmingham.
T. W. Ward, Albion Works, Sheffield.
West Hydraulic Engineering Co. (see Vauxhall and West Hydraulic Engineering Co. Ltd.), 23, College Hill, London, E.C.
Winn, Charles, & Co., St. Thomas Works, Birmingham.
Yorkshire Machine Tool and Engineering Works, Liversedge, Yorks.

Marks.
Pryor, Edward, & Son, 68, West Street, Sheffield.

Metals.
Delta Metal Co., Ltd., East Greenwich, London, S.E.
Magnolia Anti-Friction Metal Co., Ltd., of Great Britain, 49, Queen Victoria Street, London, E.C.
Phosphor Bronze Co., Ltd., Southwark, London, S.E.

Metals (Perforated).
W. Barns & Son, Chalton Street, Euston Road, London, N.W.
Brown, Andrew, & Co., 110, Cannon Street, London, E.C.
Méguin, Fr., & Co., Ltd., Engineering Works, Dillingen-on-Saar.

Mining Drill Steel.
Flockton, Tompkin & Co., Ltd., Newhall Steel Works, Sheffield.

Mining Machinery.
Fraser & Chalmers, Ltd., 3 London Wall Buildings, London, E.C

Office Appliances.
Davis, John, & Son, Ltd., &c., All Saints Works, Derby
Halden & Co., J., 8, Albert Square, Manchester.
Hall & Co., B. J., 39, Victoria Street, London, S.W.
Inglesant, T., & Sons, Ltd., Atlas House, Leicester.
Lyle Co., Ltd., Harrison Street, Gray's Inn Road, London, W.C.
Rockwell-Wabash Co., Ltd., 69, Milton Street, London, E.C.
Shannon, Ltd., Ropemaker Street, London, E.C.
Trading and Manufacturing Co., Ltd., Temple Bar House, Fleet Street, London, E.C.

Oils, &c.
Blumann and Stern, Ltd., Plough Bridge, Deptford, London.
Wells, M., & Co., Hardman Street Oil Works, Manchester.

Oil Filters and Cabinets.
Valor Co., Ltd., Rocky Lane, Aston Cross, Birmingham.

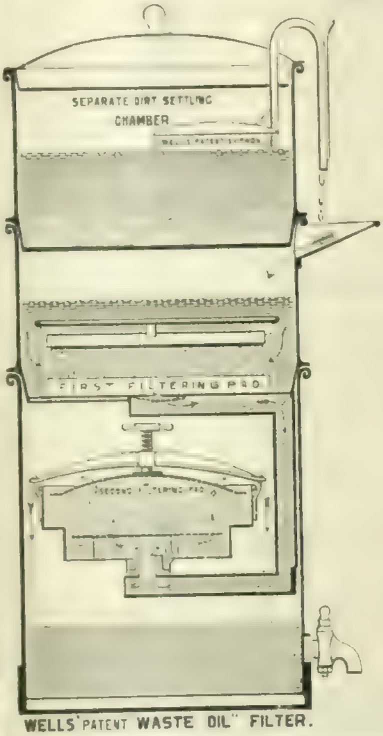
Packing.
Beldam Packing & Rubber Co., 93-94, Gracechurch Street, London, E.C.
Lancaster & Tonge, Ltd., Pendleton, Manchester.
Redfern & Co., S., Swan Lane, New Brown Street, Manchester
Quaker City Rubber Co., Coronation House, Lloyd's Avenue, E
United States Metallic Packing Co., Ltd., Bradford.
J. Bennett von der Heyde, 6, Brown Street, Manchester

Paper.
Lepard & Smiths, Ltd., 29, King Street, Covent Garden, London, W.C.

PAGE'S WEEKLY Wells' Specialities

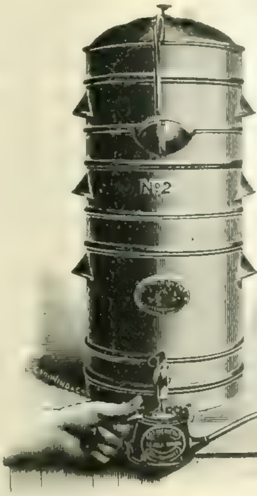
WELLS' PATENT "Waste Oil" FILTERS

FITTED WITH SIGHT-FEED SYPHON.



WELLS' PATENT WASTE OIL" FILTER.

SUPPLIED TO THE PRINCIPAL GOVERNMENTS FOR THE NAVY, DOCKYARDS, &c., AND TO THE LEADING ELECTRIC LIGHT INSTALLATIONS, ENGINEERING WORKS, GAS ENGINE MAKERS, PRINTERS, &c., &c.



OVER *11,000* SOLD.

MONEY SAVERS to any USERS OF MACHINERY.

Pay first cost in a short time, as Dirtied Oil, which has hitherto been thrown away, can be filtered and used again and again.

Write for List of **Testimonials and Samples of Work done by the Filter.**

No. 1.—For users having only a small quantity of oil to treat (no syphon) 12 in. by 9 in.	35/-
No. 2.—Four top chambers hold about 3 gallons oil 22 in. by 10 in. ..	50/-
No. 3.—Four top chambers hold about 8 gallons oil 27 in. by 12 in. ..	70/-
No. 4.—Four top chambers hold about 12 gallons oil, 36 in. by 16 in. ..	110/-
No. 5.—Four top chambers hold about 24 gallons oil, 43 in. by 23 in. ...	189/-
No. 6.—Very powerful Filter for treating large quantities of oil, 54 in. by 30 in.	336/-

Capable of dealing with **250** Galls Oil per week

LARGER SIZES MADE TO ORDER.

NO OUTSIDE POWER REQUIRED.

LIME, WHITING, OR COLD WATER PAINTS,

Applied at a speed of from 8 to 10 square yards per minute, in a manner superior to brush work.

One coat with the Machine on rough surfaces is equal to two applied with brushes.

Will save First Cost in a Few Days.

No. 6A.	Small size with Detachable Rail	£5 15s.
No. 4.	Price, with 5 ft. Pole, Single Spraying Nozzle, and 20 ft. Special Armoured Hose. Capacity 6 gals.	£8 10s.
No. 4A	Price, with Wheels, 5 ft. Pole, Single Spraying Nozzle, and 20 ft. Special Armoured Hose, **Same capacity as No. 4 Machine.**	£9 10s.
No. 5.	With 5-ft. Pole, Double Spraying Nozzle, and 20 ft. Special Armoured Hose Large Size. Capacity 10 gals	£10 10s.
No. 5A.	Ditto Ditto fitted with Wheels.	£11 15s.

WELLS' "LIGHTNING" LIME & COLOR WASHER

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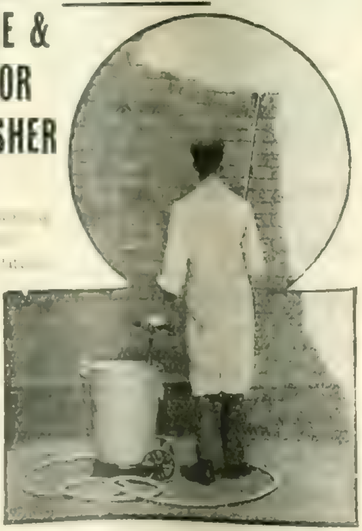


No. 4a, with Wheels.

WELLS' IMPROVED LIMEWASH.

MUCH SUPERIOR TO ORDINARY LIMEWASH. SLAKED WITH WATER QUICKLY MIXED. WILL NOT RUB OFF. LEAVES A GOOD SURFACE.

Price 13/8 per cwt.,
Carriage Paid in England and Wales, (If in lots of 3 cwt. at a time, 12/8 per cwt.)

A. C. WELLS & Co.,
100a, Midland Road, St. Pancras,
Works: Cheetham, Manchester. LONDON, N.W.

Buyers' Directory—(*Continued*).

Photo Copying Frames.
J. Ha[illegible] & Co., [illegible] Albert Square, Manchester.
B. J. E[illegible] & Co., [illegible] Victoria Street, London S.W

Photographic Apparatus.
Ma[illegible] 2 and 23, Soho Square London, W

Pinch Bars.
Samson & Co., Garforth, near Leeds.

Pipe Wrenches (Chain).
W[illegible] J. H. & Co., Brooklyn, New York, U.S.A

Pistons.
Lancaster & Tonge, Ltd., Pendleton, Manchester

Planished Sheets.
Zeitz & Co., 21 Lime Street, London, E.C

Pneumatic Tools.
Consolidated Pneumatic Tool Co., Ltd., Palace Chambers, 9, Bridge Street, Westminster, S.W.

Porcelain.
Gustav Richter Charlottenburg, near Berlin, Germany

Presses (Hydraulic).
Greenwood & Batley, Albion Works, Leeds
Niles-Bement-Pond Co., 23-25, Victoria Street, London, S.W

Publishers.
Charles Griffin & Co., Ltd., Exeter Street, Strand, London, W.C
Spon, E. and F. N., 125, Strand, W.C.
New Zealand Mines Record, Wellington, New Zealand.

Pumps and Pumping Machinery.
Drum Engineering Co., 33, Brook Street, Bradford.
Enke, Carl, Schkeuditz-Leipzig, Germany.
Fraser & Chalmers, Ltd., 3, London Wall Buildings, London, E.C
J. P. Hall & Sons, Ltd., Peterborough.
Hathorn, Davey & Co., Ltd., Leeds, England.
Positive Rotary Pumps, Ltd., 23, Northumberland Avenue, London W.C.

Radial Drilling Machines.
Asquith, William, Ltd., Well Road Works, Halifax.
Greenwood & Batley, Albion Works, Leeds.
M[illegible], P., & Co., Ltd., Parsonage Works, Keighley.
Niles-Bement-Pond Co., 23-25, Victoria Street, London, S.W.
Noble & Lund, Ltd., Felling-on-Tyne.
Northern Engineering Co. (1900), Ltd., King Cross, near Halifax.
Swift, George, Clarence Ironworks, Halifax.

Rails.
Wm. Firth, Ltd., Leeds.

Riveted Work.
P. A. Keep, Juxon & Co., Forward Works, Barn Street, Birmingham.

Roller Bearings.
Hyatt Roller Bearing Co., 47, Victoria Street, London, S.W

Roofs.
D. Anderson & Son, Ltd., Lagan Felt Works, Belfast.
Head, Wrightson & Co., Ltd., Thornaby-on-Tees.
McTear & Co., Ltd., Newtownards Road, Belfast

Ropeways (Aerial).
Bu[illegible] & Co., Ltd., 72, Mark Lane, London, E.C.
P[illegible]gne, Germany.

Scientific Instruments.
Cambridge Scientific Instrument Co., Ltd. Cambridge.

Slotting Machines.
Swift, George, Clarence Ironworks, Halifax.

Spanners.
W[illegible] Co., Brooklyn, New York, U.S.A

Stampings.
Thomas Smith & Sons of Saltley, Ltd., Birmingham.
Williams, J. H., & Co., Brooklyn, New York, U.S.A.

Stamps (Rubber).
Rubber Stamp Co., 1 & 2, Holborn Buildings Broad Street Corner, Birmingham.

Stamps (Metal).
Edward Pryor & Son, 68, West Street, Sheffield.

Steam Traps.
Lancaster & Tonge, Ltd., Pendleton, Manchester.

Steam Wagons.
Thornycroft & Co., Ltd., J. I., Chiswick, London, W.
Yorkshire Patent Steam Wagon Co., Pepper Road, Hunslet, Leeds.

Steel Structures.
Ashmore, Benson, Pease & Co., Ltd., Stockton-on Tees.

Steel Tools.
Saml Buckley, St. Paul's Square, Birmingham.
Pratt & Whitney Co., 23-25, Victoria Street, London, S.W.

Steel (Tool Steel).
Flockton, Tompkin & Co., Ltd, Newhall Steel Works, Sheffield

Stokers.
Ed. Bennis & Co., Ltd., Bolton, Lancs.

Stone Breakers.
S. Pegg & Son, Alexander Street, Leicester.

Superheaters.
A. Bolton & Co., 40, Deansgate, Manchester.

Time Recorders.
Howard Bros., 40, Paradise Street, Liverpool, and 100b, Queen Victoria Street, London, E.C.

Tubes.
Thomas Piggott & Co., Ltd., Spring Hill, Birmingham
Tubes, Ltd., Birmingham.

Turbines.
Greenwood & Batley, Albion Works, Leeds.
S. Howes Co., 64, Mark Lane, London, E.C.

Typewriters.
Empire Typewriter Co., 77, Queen Victoria Street, London, E.C.
Yost Typewriter Co., 50, Holborn Viaduct, London, E.C.

Valves.
Holmes & Co., W. C., Huddersfield.
Hopkinson, J. & Co., Ltd., Britannia Works, Huddersfield.
Hunt & Mitton, Crown Brass Works, Oozells Street North, Birmingham
Scotch and Irish Oxygen Co., Ltd. Rosehill Works, Glasgow
Shaw, Joseph, Albert Works, Huddersfield.
Winn, Charles, & Co., St. Thomas Works, Birmingham.

Ventilating Appliances.
Matthews & Yates, Ltd., Swinton, Manchester

Water Softeners and Purifiers.
Lassen & Hjort, 52, Queen Victoria Street, London, E.C.

Wagons—Steam.
Thornycroft & Co., J. I., Ltd., Chiswick, London, W.

Weighing Apparatus.
W. & T. Avery, Ltd., Soho Foundry, Birmingham, England.
Samuel Denison & Son, Hunslet Moor, near Leeds.

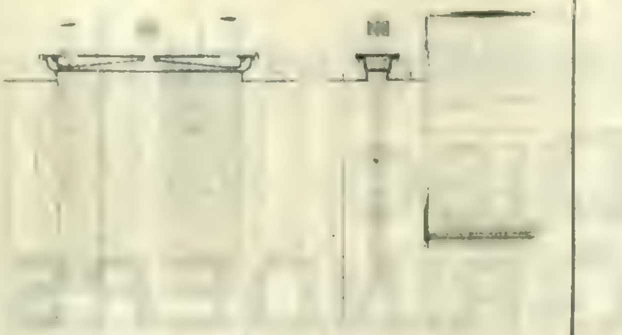
Wells Light.
A. C. Wells & Co., 100A, Midland Road, St. Pancras, London, N.W

Wire Working Machinery.
Ed. Frand 35, Shakespeare Street, Manchester.

"Woodite."
"Woodite" Company, Mitcham, Surrey.

PAGE'S WEEKLY Miscellaneous

TO STEAM USERS.



OVER 400 WORKING,

Averaging a saving of 15 per cent. of coal and 30 per cent. of water. Repeat Orders coming in.

RELIEVE YOUR BOILERS.

Increase the efficiency of your Engines and improve Production by placing BOLTON'S SUPERHEATER in the Back or Downtake Flue.

To Dry and Superheat the Steam.

[illegible] and Sole Makers

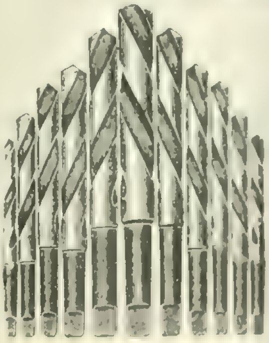
A. BOLTON & CO.,
Engineers and Contractors,
49, Deansgate, MANCHESTER.

THE TYPEWRITER FOR BEAUTIFUL WORK.

[illegible] on Application.

THE YÖST TYPEWRITER CO., Ltd.,
50, Holborn Viaduct, London.

MALLEABLE IRON & STEEL CASTINGS FOR ENGINEERS & TOOL MAKERS
TO MACHINE CLEAN & BRIGHT ALL OVER.
PARKER FOUNDRY CO. DERBY
ON ADMIRALTY LIST.



Twist Drills,
Taps,
Milling Cutters,
Reamers.

H. F. SCHNICKE,
CHEMNITZ (Saxony).

OIL SEED AND CAKE MILLS.
GRAB DREDGERS.
OIL REFINERIES.

Rose, Downs & Thompson,
LTD.,
Old Foundry, HULL,
and
12, Mark Lane, LONDON, E.C.

WATER SOFTENING PLANT.

F. A. KEEP, JUXON, & CO.,
Manufacturers of
TANKS, CISTERNS
and CONSTRUCTIONAL IRONWORK.

Forward Works,
Barn Street,
BIRMINGHAM.

PAGE'S WEEKLY Machine Tools

CUNLIFFE & CROOM, Ltd.

MACHINE TOOL MAKERS,

Broughton Lane, MANCHESTER.

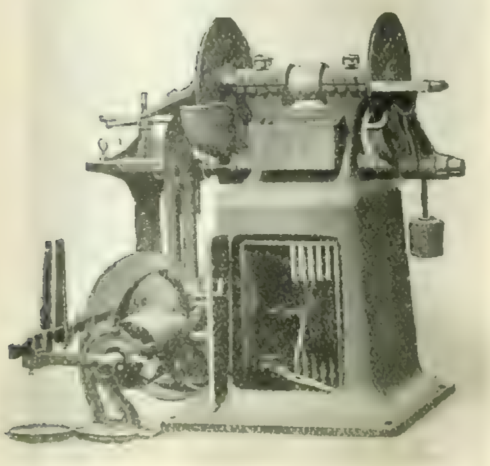


Illustration shows 18-in. Disc. Grinder. May be seen at work at our Showroom, 66, VICTORIA STREET, MANCHESTER.

DISC GRINDERS.

Made in Three Sizes: 14 in., 18 in., and 28 in.

Accessories supplied with each machine are—Screw Press; Two extra machine ground Steel Discs; Dust Shields to each Disc; One dozen Emery Paper Discs; Water Trough; Glue Kettle; Handles for lifting discs; Top Driving Apparatus.

Full particulars and printed matter upon application.

HIGH-CLASS LATHES & RADIAL DRILLS.

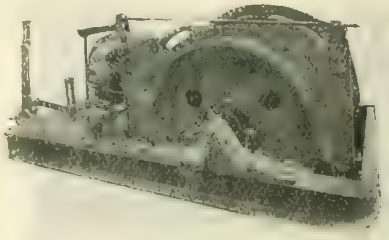
Write for our Lists.

Telegrams: "Tools, Keighley."

D. MITCHELL & CO., Ltd., Parsonage Works, KEIGHLEY.

On War Office and India Office Lists.

Electric Hauling GEARS



Main and Tail, Main Rope, Endless Rope, and Portable, Hoisting, and Hauling Gears.

M. B. WILD & CO., 35 and 36, Clarence Chambers Corporation Street, BIRMINGHAM.

Telegrams: "MILLING, SHEFFIELD.
National Telephone No.: 985.

For the Latest and most Up-to-Date

HEAVY = = MACHINE TOOLS = =

PLATE BENDING MACHINE.

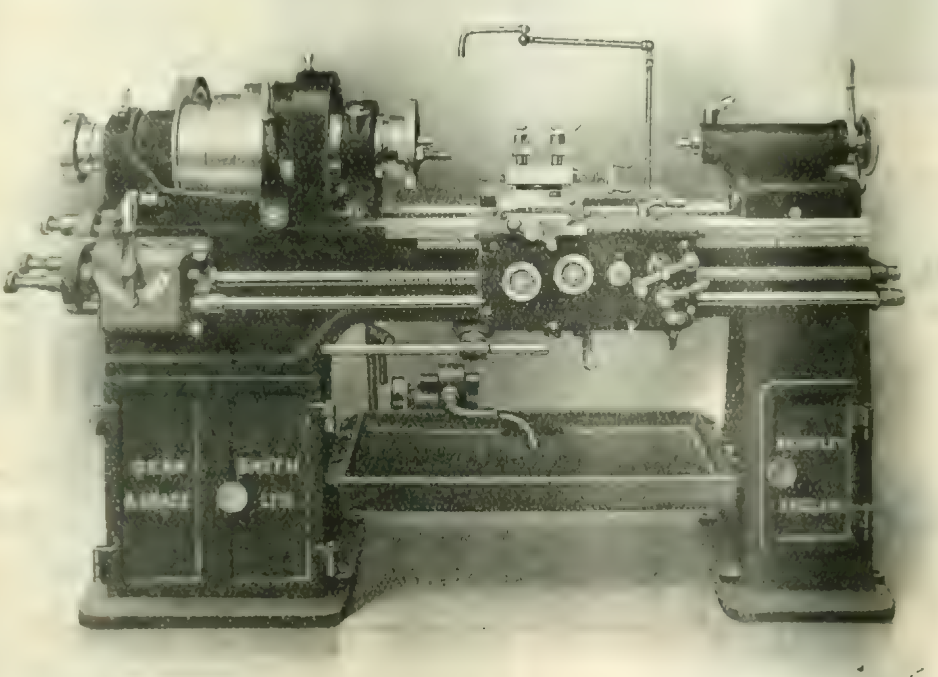
Also Special Lifting Jack for Electric Tramcars.

WRITE . .
GEORGE ADDY & Co.,
WAVERLEY WORKS, SHEFFIELD.

High-Speed Lathes

FOR ALL CLASSES OF WORK
are our sole Manufacture.

SPECIAL DESIGNS. UNIQUE FEATURES.



6-in. High Speed Lathe, with Friction Geared Head and Hollow Spindle, taking 2½ in dia. Bar.

IF INTERESTED, WRITE FOR OUR 1906 CATALOGUE.
IT WILL BE WORTH YOUR WHILE

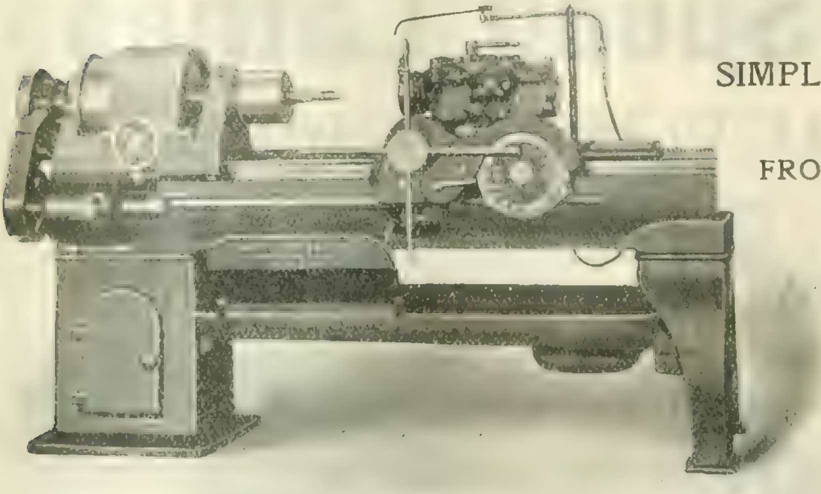
DEAN, SMITH & GRACE, Ltd., KEIGHLEY, England.

ESTABLISHED 1865

Agents for London: BUCK & HICKMAN, Ltd., Whitechapel Rd., E.
Agent for France: LOUIS BESSE, 39, Rue de Lappe, Paris.

PAGE'S WEEKLY Machine Tools

TURRET LATHE SPECIALISTS.



Note the
SIMPLICITY of this LATHE.

DIRECT DRIVEN
FROM THE MAIN SHAFT.

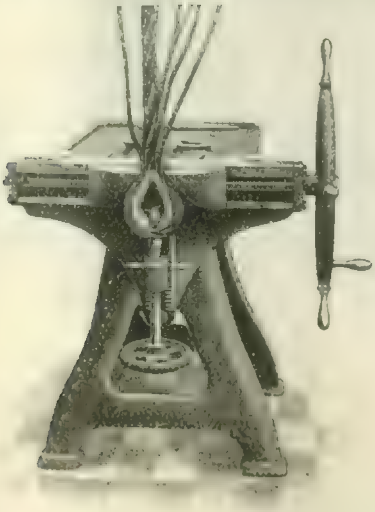
VARIABLE SPEED HEADSTOCK.

The RACK and GUIDE direct under the cutting tool being completely covered.

ALL HANDLES and STOPS within reach of the Operator.
THE ONLY CORRECT GRIP CLUTCH.

Telegrams : "CRITERION, LINWOOD."
Telephone : 4Y JOHNSTONE.

ECLIPSE TOOL MFG. CO., Linwood, nr. Glasgow.



Cable Bending and Splicing Vise.

SEND FOR DESCRIPTION

J. PARKINSON & SON,
SHIPLEY, ENGLAND.

Cables: "TEMPLES, SHIPLEY." Code: A B C 5th Edition

ALL OUR LATHES

ARE FITTED WITH

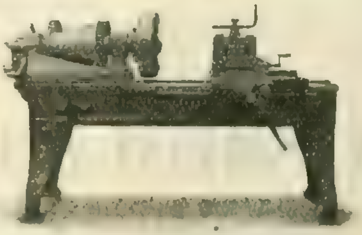
Patent Bed, Patent Loose Head,
Patent Screw-Cutting and Feed Motions.

INVESTIGATE THESE POINTS BEFORE BUYING.

JOHN LANG & SONS,
Johnstone, near GLASGOW.

HIGH SPEED LATHES

OUR SPECIALITY.

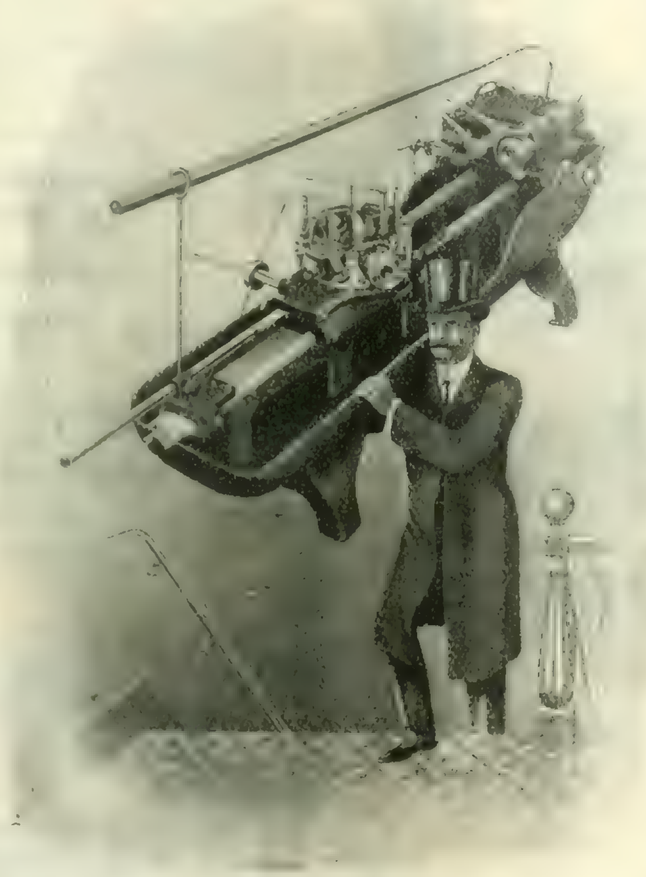


HIGH-GRADE MACHINES
only, in stock for Immediate Delivery.

(Established 1871.

C. REDMAN & SONS, Parkinson Lane, HALIFAX.

It would be Impossible



For our Representative to carry a machine on his shoulder

when he comes to interview you regarding the purchase of a Hartness Flat Turret Lathe,

But, if you will call at our premises,

97, Queen Victoria Street, London, one of our expert operators will take very great pleasure in demonstrating to you the merits of our New Model Hartness Flat Turret Lathe, with Cross Sliding Head,

☛ **The only Turret Lathe of the kind on the Market.**

COME AND SEE IT WORKING.

JONES & LAMSON MACHINE CO.,

"Jubilee Buildings," 97, Queen Victoria Street, LONDON, England.

TELEGRAMS: "TURRETORUM, LONDON." [illegible] BANK, LONDON.

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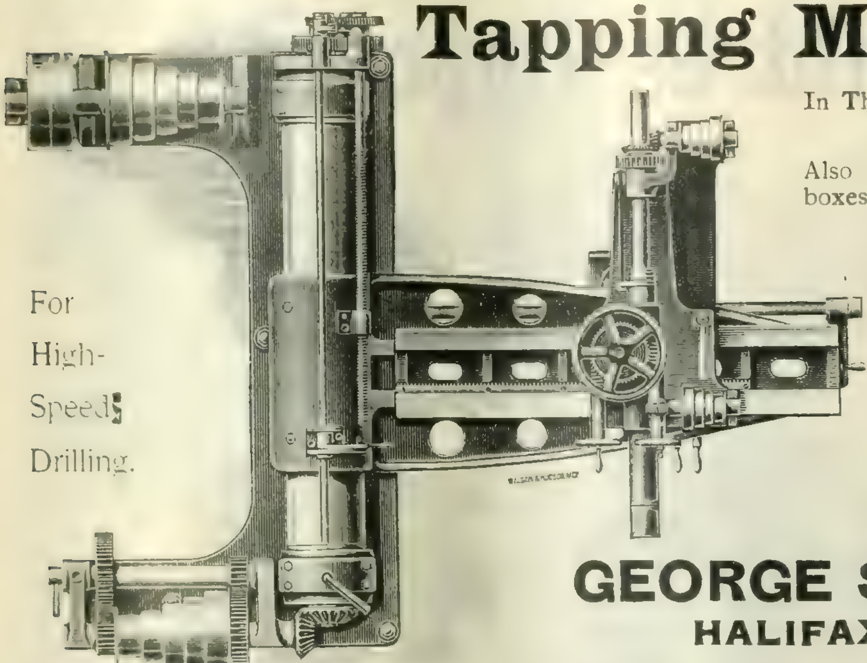
PAGE'S WEEKLY Machine Tools

Wall Radial Drilling and Tapping Machines.



For High-Speed Drilling.

In Three sizes, from 4 ft. 6 in. to 7 ft. 6 in. radius.

Also made with speed and feed boxes giving sixteen speeds and nine feeds.

ESTABLISHED 1884.

Contractor to H.M. Government.

Complete Catalogue on request.

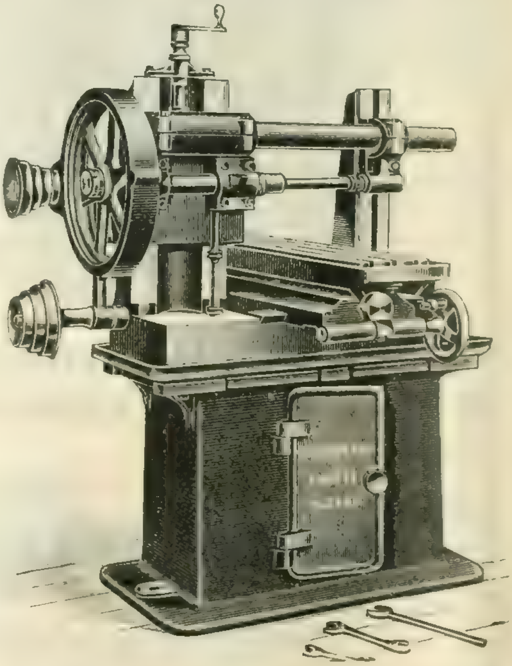
GEORGE SWIFT, Clarence Iron Works,
HALIFAX, England.

Telephone No.: 497. *Telegrams: "Swiftly, Halifax."*

BRADBURY'S

Newly Designed

Standard Milling Machine



For

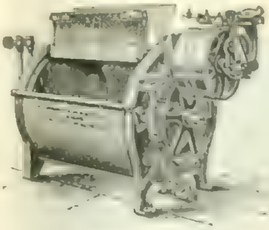
SPEED,
ACCURACY,
ADAPTABILITY,

IS **A 1.**

Prices and Particulars from - -

BRADBURY & Co., Ltd., Wellington Works, *OLDHAM.*

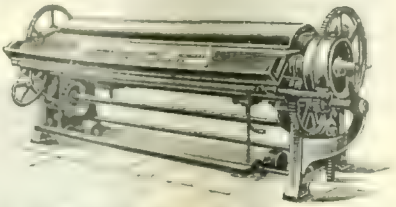
PAGE'S WEEKLY Machine Tools, &c.



LAUNDRY

MACHINERY

and Steam COOKING APPARATUS.



Please write for our New Catalogue, **N.**

Summerscales, Ltd., KEIGHLEY, ENGLAND.

THE

Jos. C. Nicholson Tool Co.,

Machine Tool Makers, NEWCASTLE-ON-TYNE.

Horizontal, Vertical Pillar, Radial, and Wall Radial

DRILLING MACHINE

Sole Makers of the "STANDARD" Hand Power WELDING and FORGING MACHINE.

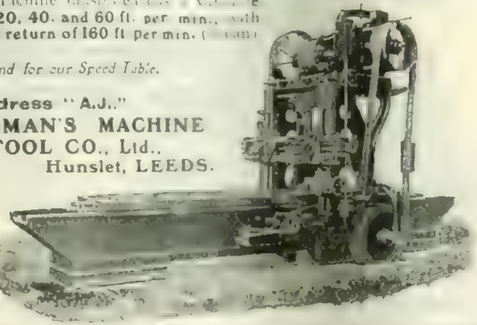
Write for "Green" Catalogue.

BATEMAN THREE-SPEED PLANERS

The Machine illustrated has a variable cut of 20, 40, and 60 ft. per min., with constant return of 160 ft per min. ([illegible])

Send for our Speed Table.

Address "A.J.,"
BATEMAN'S MACHINE TOOL CO., Ltd.,
Hunslet, LEEDS.



[illegible] in. x [illegible] ft. [illegible], with three-speed gear box

Dempster, Moore & Co., Limited,

ENGINEERS, GLASGOW.

Modern Machine Tools of all Kinds.

SPECIALITY–LATHES FOR HIGH-SPEED CUTTING.

From a Photograph of a 9½-Inch High-Speed Lathe.

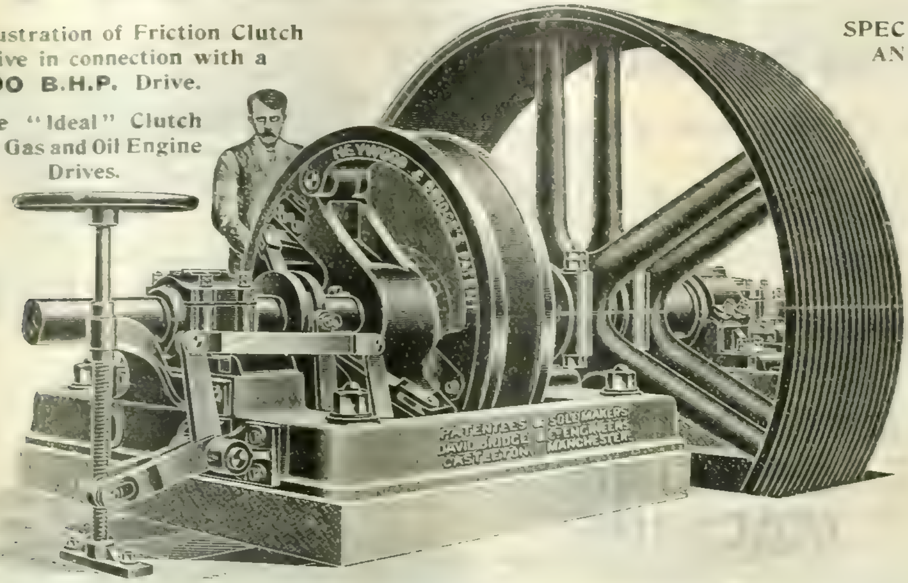
PAGE'S WEEKLY Machine Tools, &c.

HEYWOOD & BRIDGE'S PATENT FRICTION CLUTCHES AND COMPLETE HAULING AND GEARING INSTALLATIONS.

NO SHOCK OR JAR.

Illustration of Friction Clutch Drive in connection with a **400 B.H.P.** Drive.

The "Ideal" Clutch for Gas and Oil Engine Drives.



SPECIFY OUR CLUTCHES AND YOU WILL NOT REGRET IT.

SEND FOR 200 Page Work Free.

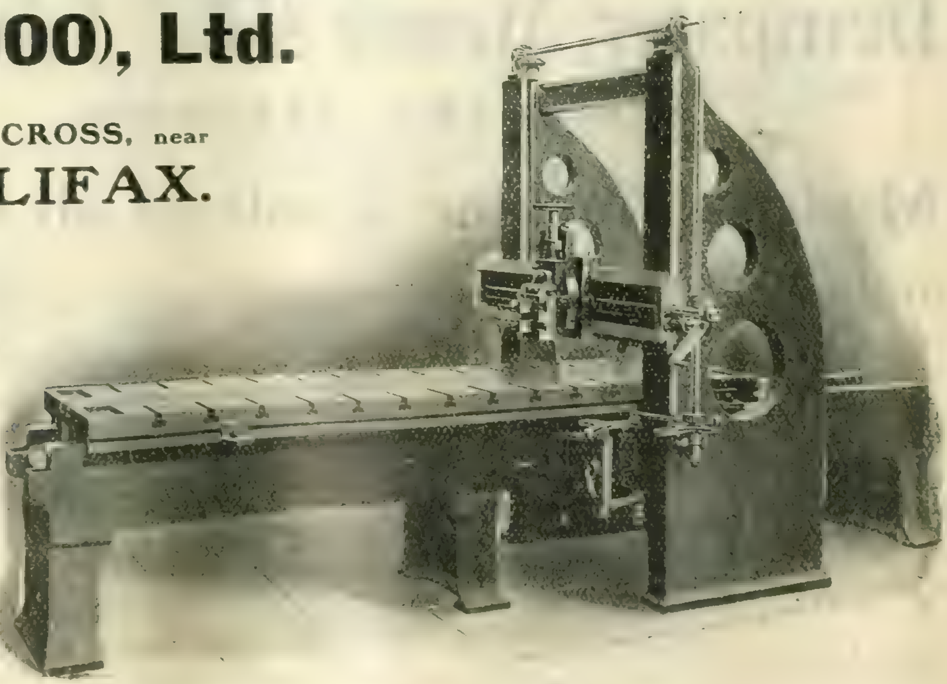
It will tell you all about our Clutches and Gears.

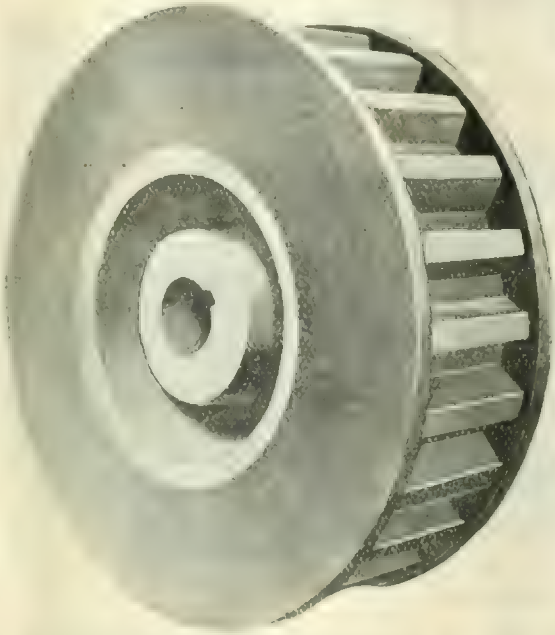
DAVID BRIDGE & CO., Patentees and Sole Makers,
LONDON OFFICE: 35, Queen Victoria St., E.C.
Castleton Iron Works, ROCHDALE, LANCS.

Northern Engineering Co. (1900), Ltd.

KING CROSS, near
HALIFAX.

PLANING MACHINE from 2 feet up to 8 feet square.





Buffalo-Raw-Hide GEAR PINIONS and WHEELS.

As supplied to
ADMIRALTY, WAR OFFICE,
DOCKYARDS, and ROYAL MINT.

TRY THIS CALCULATION.

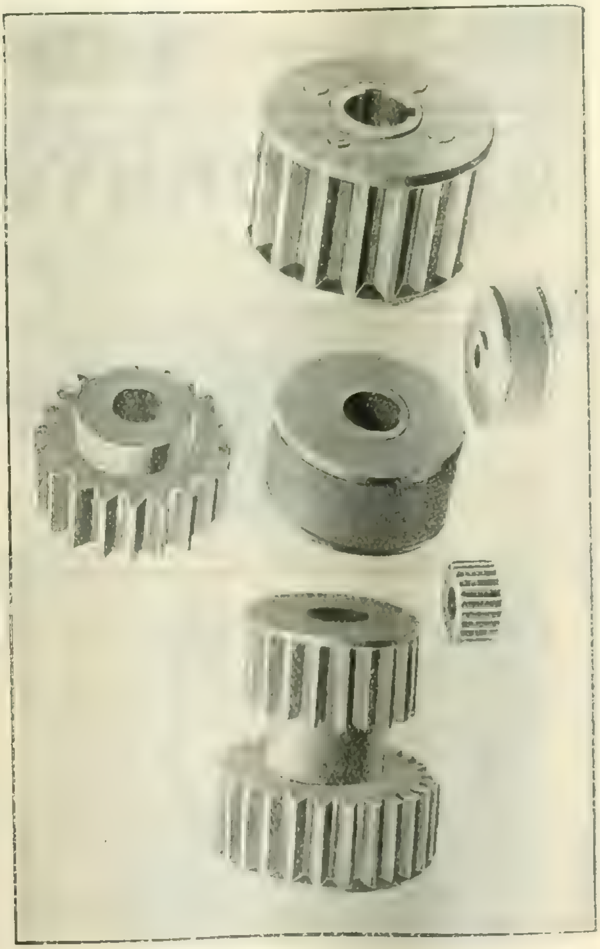
1 ft. diameter, 8[illegible]0 revs. per minute,
140 hours per week
=4,0[illegible] miles per week.

SEVEN YEARS IN USE AND STILL RUNNING IN GOOD CONDITION.

NOISELESS,
DURABLE.

Estimates for Complete Sets of Gearing on application to—

W. F. DIXON & CO.,
60, Percival Street, C.-on-M.,
MANCHESTER.



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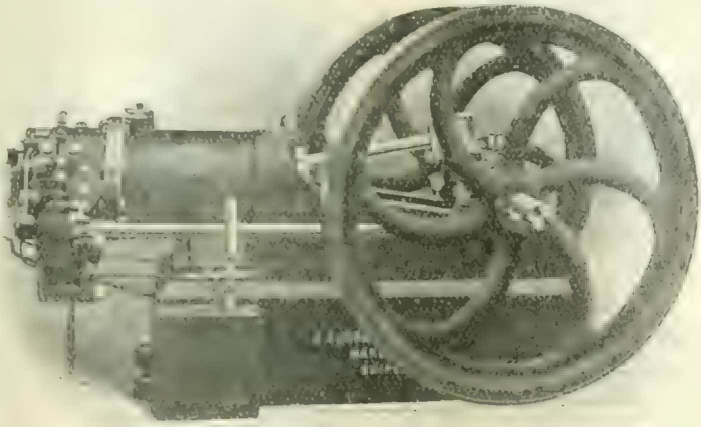

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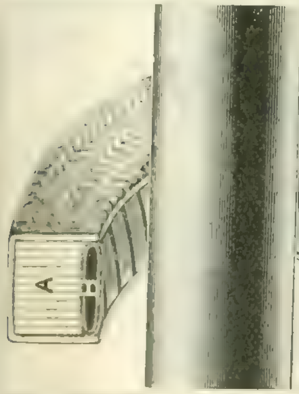

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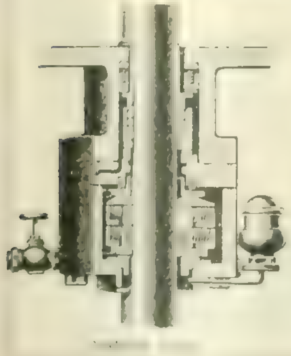

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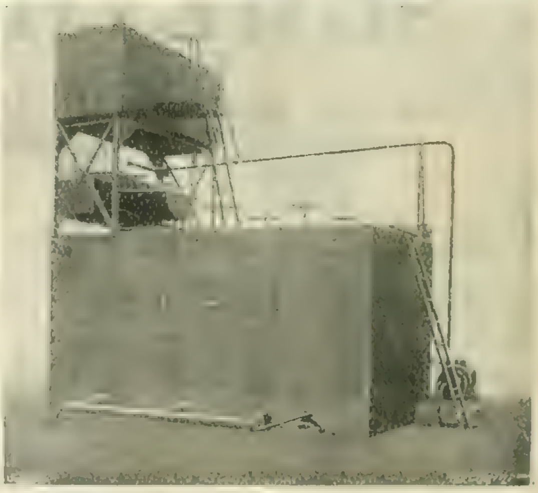

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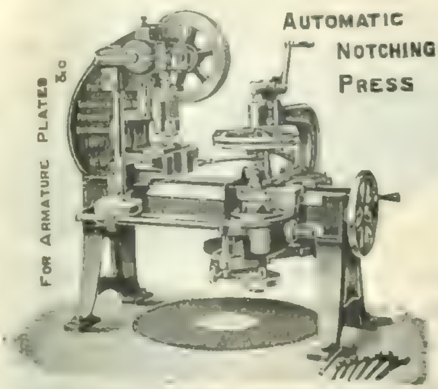

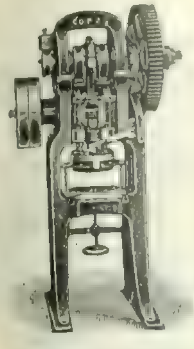

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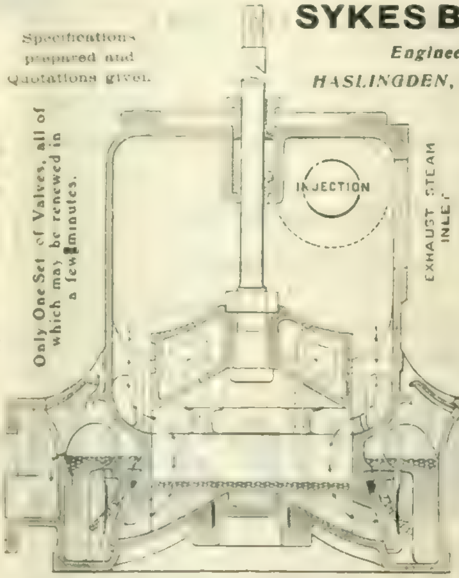

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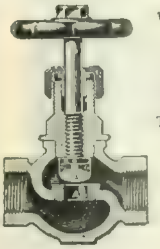

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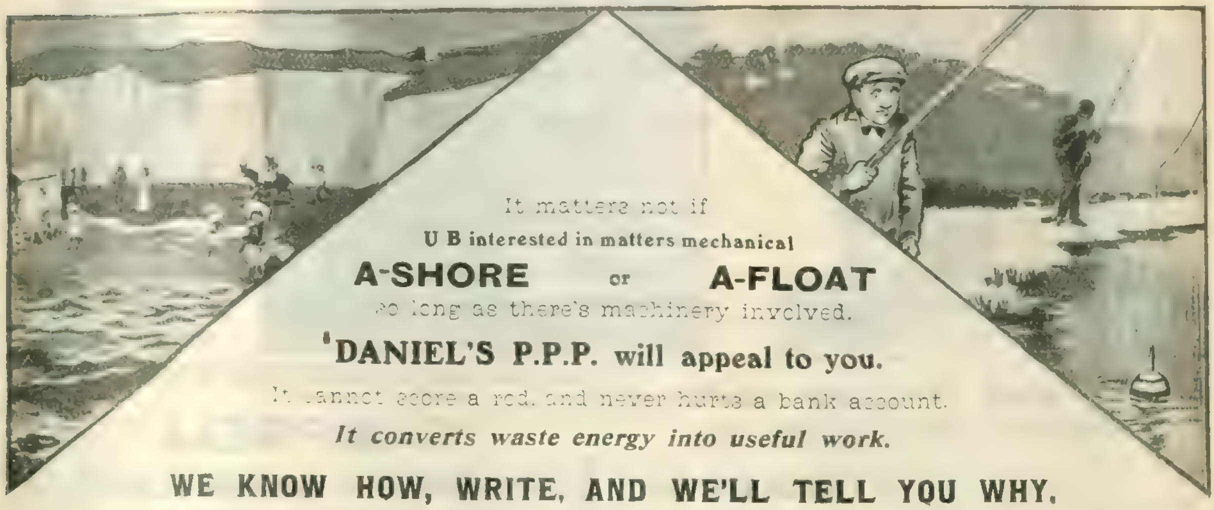

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PAGE'S WEEKLY

An Illustrated Technical Weekly, dealing with the Engineering, Electrical, Mining, Iron and Steel, and Shipbuilding Industries.

VOL. VII. LONDON, FRIDAY, DECEMBER 29, 1905. No. 68

The Offices of "Page's Weekly,"
Wednesday Evening.

POINTS to which special attention will be directed in connection with the trials of suction gas plants to be made at the Derby show of the Royal Agricultural Society will be: (1) Attendance necessary; (2) general design, including facility of cleaning, and space occupied; (3) regularity of working; (4) fuel consumption, water consumption; (5) price; (6) relative proportions of gas producer and engine; (7) volume swept by piston relative to brake horse-power. The official regulations (which can be obtained from the secretary, at 13, Hanover Street, W.) provide that specifications and drawings must be sent in by the 15th of March next. Each exhibit is to comprise gas generating plant and engine, complete of 15 to 20 b.h.p. as a maximum. A special shed will be provided by the society for the trials of these plants, and for their subsequent exhibition during the show. The trials will take place during the week previous commencing on Monday, June 18th, 1906. The awards will be published immediately after the conclusion of the trials.

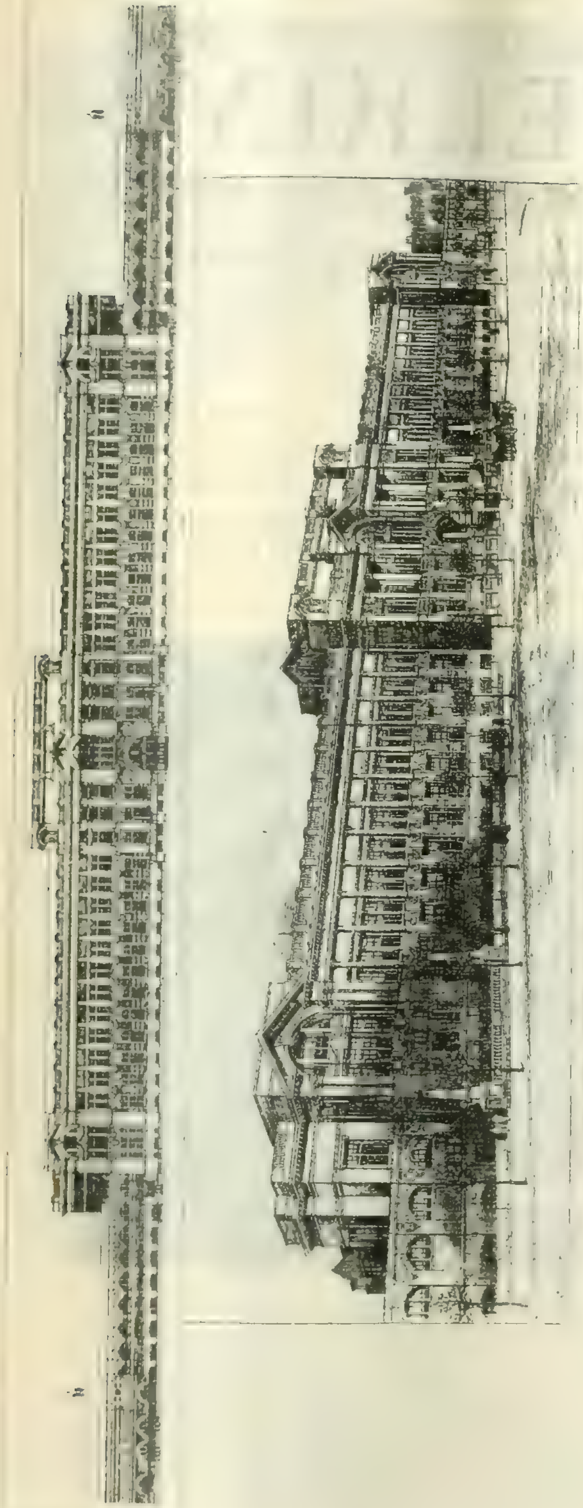
—

Each exhibitor of suction gas plant will be required to declare at what brake horse-power he intends to run his engine for the full-load trial, and no variation therefrom beyond 5 per cent. more or less, will be allowed. Full-load, half load, and light or no-load trials will be made with uniform selected anthracite coal provided by the Society. A subsequent full-load trial will be made with coke as fuel. Each plant will be started from cold on the full-load trial. The first full-load trial will be

Phot., Elliott and Fry.

R. T. GLAZEBROOK, M.A., D.SC., F.R.S.,
Director of the National Physical Laboratory.

An institution which has [illegible] much discussed in view of the memorial signed by members of the House of Commons calling for a larger [illegible] grant. The laboratory has undertaken over 23[illegible] in addition to valuable research work. Dr. Glazebrook [illegible] and educated at Liverpool College, and [illegible] (fifth Wrangler) at Trinity College Cambridge. He [illegible] a Fellow of his Alma Mater [illegible] 1877, and [illegible] appointment to his present post he was Principal of the [illegible] College.



THE NEW ROYAL COLLEGE OF SCIENCE AT SOUTH KENSINGTON.

commenced with the gas generators empty. The engines will run for nine hours under constant load, after which they will be shut down for the night, and will resume running on the following day. At the conclusion of the trials the fires will be drawn, and any unconsumed coal will be weighed back and credited for what it may be worth. The half-load trials will be conducted on precisely the same lines as the full-load trials, with the exception that they will be of shorter duration. The light or no-load trial will be of two hours' duration. No coal consumption will be recorded for this trial. No working of the fan by hand will be permitted during the half load and light or no-load trials. On the completion of the above trials, one full load trial of nine hours' duration will be made, using coke as fuel.

We reproduce herewith, by permission of the architect, Sir Aston Webb, drawings of the new Royal College of Science at South Kensington. The new building is rapidly nearing completion, and, as may be judged by the illustrations, it will be one of the most notable architectural features of that part of London. It is expected that the buildings will be formally opened early in the new year.

A telegram from the Earl of Elgin to the Governor of the Transvaal, sets forth the decision of the Government that "the experiment of the introduction of Chinese labourers should not be further extended until they can learn the opinion of the colony through an elected and really representative Legislature. They have accordingly decided that recruiting, embarkation, and importation o Chinese coolies shall be arrested pending a decision as to the grant of responsible government to the colony. They are not prepared in all the circumstances to be responsible for further importation. His Majesty's Government trust that the inhabitants of the Transvaal will recognise that they have felt it their duty to take this step deliberately and after a careful review of the situation.

The Journal of the Royal United Service Institution prints the conclusions of Mr. Charles Bos on the lessons in naval construction to be learnt from the Russo-Japanese War. These are contained in a report to the French Chamber of Deputies on the Naval Estimates for 1906. In the first place, says this authority, the effective ranges for battle having been more than doubled—raised from 3,000 to 7,000 or 8,000 yards—it follows that medium artillery ought to disappear from the armament of battle-ships. It is only necessary to have guns of large calibre, and, for preference, a single type, throwing a somewhat heavier projectile with a slightly reduced initial velocity. The quick-firing small guns for use against torpedo-boats should have a calibre of at least 3 in., and perhaps of 4 in., with as heavy a projectile as possible, and a very high initial velocity; some 3-pounders might be added for use at short ranges. The reduction to a single calibre of the heavy gun armament, and the adoption of a 3-in. or 4-in. type for small guns would facilitate the supply of ammunition, and in view of the alarming expenditure of projectiles the proportion of ammunition carried would have to be considerably increased. There should be one type of gun, one single projectile for the heavy artillery, to facilitate supply: the shells to be of steel, capped and charged with a high explosive. The hull should be protected by armour deeper below the waterline than at present, which should also be carried higher up the hull, so as to prevent the destruction of the decks. The guns should for preference be in pairs and mounted in turrets. Those which were in casemates during the late war, were easily put out of action and their shields completely destroyed. Damage to the rudder and steering gear having been frequent, it is necessary the stern of ships should be protected; and as many of the stations for the transmission of orders electrical and hydraulic, have also been destroyed, these must be placed under the armoured decks behind armour. At a long range what is visible of a ship is the superstructure. In French ships, as in those of Russia, this is very heavy; the masts are too large, and carry tops too heavy for light guns. All this makes an admirable target, and if a mast is shot away it causes the death of a number of men. The masts, then, must be reduced and made as light as possible. A range-finding position on each mast is all that is necessary. The superstructure being destroyed, there are no small guns to repel torpedo-boat attacks; from this it follows that the light guns ought to be grouped under an armoured deck, or protected if placed on the upper deck. The magazine should also be placed as near as possible to each battery.

Following the same order of ideas, the funnels should be modified and some measure of protection given them. For the same reason, the conning-tower should not be so much in sight, should not be so high, and should be better protected. The wireless telegraphy room should not be in one of the masts; a station below the armoured deck should be sufficient. Battles taking place at long ranges, the ram is now useless and can be done away with without inconvenience. For the same reason, in large ships the torpedo tubes have no *raison d'être;* the space they occupy, as well as the stowage for the torpedoes would be better employed for shell stowage. No armour having been penetrated, its thickness can be diminished, and parts of a ship which have not been up to the present protected, or have been badly so, should now be covered. It is, above all important, that the side behind which are the magazines and ammunition supplies should be well armoured.

The gain in weight for the suppression of the ram and torpedo tubes could be used for the armament and ammunition. Finally, the battle ranges having considerably increased it is neccessary that the gunners should be continually exercised at long range target practice, and that all ships should consequently be furnished with several range-finders, and all the guns with telescopic sights. On the other hand, it is expedient that battle-ships should be protected against the torpedo. For this object it would seem advisable to give all ships a double hull, with numerous water-tight compartments, which should be filled with coal, or a cofferdam with cellulose, etc.—whatever may be best fitted to weaken the effects of the explosion. Lastly, it is necessary to take into account the factor of speed. All naval nations are laying down battle-ships which are to steam between 19 and 20 knots. An 18-knot trial speed which represents a sea-speed of 16·5 knots, is absolutely insufficient. In our own navy, at any rate, it is satisfactory to know that the more important of these conclusions are already receiving attention.

— — —

The aims and work of the Hamburg Smoke Abatement Society, were briefly explained by Mr. B. C. Kershaw at the recent Smoke Abatement Conference. This society, as many of our readers will be aware, is a voluntary association of steam users, who aim at the suppression of smoke and the promotion of fuel economy, and the practical lesson which we in this country have to learn from the work of the Hamburg Society is that the emission of black smoke is largely preventible, and that the smokeless combustion of fuel promotes economy when carried out under proper supervision. This is precisely the conclusion arrived at by Dr. Rideal's statistics, and Mr. Kershaw is of opinion that an organisation like the Hamburg Society, which enables manufacturers to combine together, to attack the evil at its source—*i.e.*, the boiler and heating installations in their own works—should be started in every large centre of manufacturing industry in this country.

A subject of great interest was discussed at the Institution of Civil Engineers last week, when Mr. A. J. Mavor in a paper on heat economy in factories suggested that heat production and distribution should be dealt with by a system of double-entry accounts, the boilers being debited with the heat represented by the coal and credited with the heat represented by the steam. These credits are carried to the debit of accounts dealing with the various uses to which the steam is put in the factories. These accounts, again, are credited with the work performed, the balances being carried to a balancing account, which brings out the efficiency of the prime mover, and separates out the useful work and the losses in such form that the losses can be divided into necessary and avoidable losses, the whole giving a comprehensive view of the conditions of efficiency in terms of British thermal units.

—

Six specimen balance-sheets are given by Mr. Mavor, and the accounts are shown in detail, the cases chosen comprising :—

A factory in which there is a small amount of heating and a number of steam engines ; a factory where the power is obtained from one large engine and the heating occupies a prominent place ; a similar factory where there are many engines and a scattered and complicated heating system ; a factory where there are a number of engines of various sizes and a considerable amount of heating and boiling ; and a blast-furnace plant. The balancing account in each case are discussed in detail and indications are given of the methods of arriving at the results, showing the bearing which the ascertained efficiencies have upon existing methods of working and proposed modifications thereof.

PAGE'S WEEKLY

An Illustrated Technical Weekly, dealing with the Engineering, Electrical, Mining, Iron and Steel, and Shipbuilding Industries.

DAVIDGE PAGE, Editor.

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NEWS ITEMS.

At [illegible] the Birmingham Association of Mechanical Engineers [illegible] presentation of a diploma was made to Mr. E. A. Dowson for the best paper contributed [illegible]

A scheme for improving the navigation of the River Trent to the Humber is to be considered by a Committee of the Newark Navigation Commissioners and the Trent Navigation Company.

The [illegible] Institution of Engineers and Shipbuilders in Scotland have now drawn up the conditions for plans for their new buildings in Elmbank Street, Glasgow. The competition is confined to local architects.

Just now when we are hearing so much about fog and the waste products of combustion, a paper on "Boiler-house Economics," by Mr. Alfred Bennis, has an enhanced interest. An abstract will be found at page 1438.

Mr. Walter Broadbridge, Assoc.Inst.M.M., has been appointed consulting engineer to the South African Lands and Exploration Company, Ltd., for their tin properties, Mr. G. A. Troye, M.Inst.M.M., continuing to act as consulting engineer for the other interests of the company.

It is hoped that the entire section of the London, Brighton and South Coast Railway between Victoria and London Bridge will be electrified by the Spring of 1907. The British Thomson-Houston Company is associated with the Allgemeine Elektricitäts-Gesellschaft in the undertaking, and it is understood that four-fifths of the value of the contract will be spent on work to be done in England.

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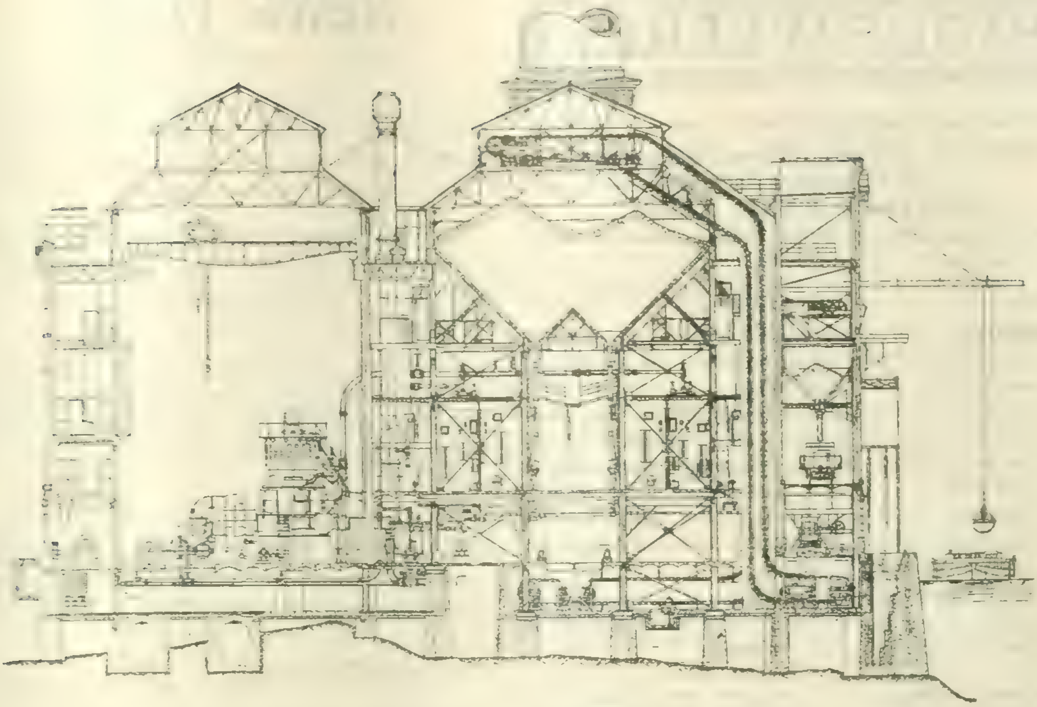


CROSS SECTIONAL VIEW OF POWER STATION AT PORT MORRIS, N.Y. (*See page* 1425.)

Engineering in Egypt.

The tendency of British manufacturers to recognise the importance of combining their interests for purposes of representation is growing apace, and it is significant, says the Egyptian Gazette, that the growing trade in Egypt and the Soudan is having the effect of causing our firms to give a great amount of attention to this part of Africa. Following closely in the footsteps of the British Engineering Company of Egypt, which represents among others Messrs. Gwynnes, Ltd., Babcock and Wilcox, and Dick, Kerr and Co., come the Egyptian Engineering Company, Ltd. The direc-t[illegible] a very [illegible] chairman is Sir Thomas Richardson, of Messrs. Richardson, Westgarth and Co., Ltd., and his colleagues on the board are representatives of the Pulsometer Engineer Company, the Teeside Bridge and Engineering Works, and Messrs. Easton and Anderson. Among the other firms represented in Egypt by this company are Messrs. R. Hornsby and Sons, Ltd., Beck and Co., Ltd., Hartlepool Ropery Co., Ltd., Midland Railway Carriage and Wagon Company, Ltd., the Harvey Engineering Company., Ltd., Browett, Lindley and Co., Ltd., John Cooke and Sons, Mason's Gas Power Company, Ltd., Erith's Engineering Company, Ltd., British Insulated and Helsby Cables, Ltd., Jessop and Appleby Bros., Ltd., R. Warner and Co., Hunter and English, Spurr, Inman and Co., Ltd., the Northern Rubber Company, the Easton Lift Company, Ltd., G. R. Turner, Ltd., etc. Mr. H. K. Baynes, the [illegible] director, has a [illegible] Egypt.

Irish Canals.

In the course of a paper recently read before the Statistical and Social Society of Ireland by Mr. E. A. Montmorency Morris, M.A., on "Canals and Waterways at Home and Abroad," the lecturer remarked that few countries were better naturally adapted for a system of waterways than Ireland. The comparative failure of the Irish canals has perhaps been due, as the late Dr. Coyne suggested, more to the successive shiftings of responsibility for their conduct and maintenance between State departments, mixed boards, local and private companies, than to any intrinsic fault in the system itself. The length of canal navigation is 586 miles. The Grand Canal is the largest [illegible] system in the United Kingdom, and its shareholders receive a steady [illegible] satisfactory [illegible] but part of the [illegible] from lands owned by the company, and from the sale of water to large brewing firms. The average yearly traffic of [illegible] canals and inland navigation is about [illegible] tons.

[illegible] NEW G.W.R. [illegible]

New Postal Train on the Great Western Railway.

[illegible] vehicles is illustrated by courtesy of the Great Western Magazine.

The new letter and parcel-sorting carriages are 70 ft. [illegible] The parcel-sorting vans are provided with the Post Office standard apparatus for the collection and delivery of mails en route; provision is also made to readily apply the apparatus to the letter-sorting cars, should this at any time become necessary. One side of the interior of each of the latter vehicles is fitted with [illegible] specially arranged for registered letters. The opposite [illegible] parcel-sorting cars are fitted on each side with sorting boxes, one side being also provided with flap tables, and the other with bag pegs, etc. The roofing of all the cars is of the latest elliptical type, with the addition of a wired glass roof which extends throughout their whole length. The cars are lighted by incandescent [illegible]

Penzance New Water Mains.

Col. A. G. Durnford, R.E., representing the Local Government Board, held an inquiry at the Guildhall, Penzance, last week, into the application of the Corporation to borrow £4,500 for the purposes of laying new water mains from the reservoir to certain parts of the town. Mr. T. H. Cornish (town clerk) explained the object of the application. The population of the district, he said, which would be supplied by water was 13,136 at the last census; the assessable value was £59,038; the balance of the outstanding loans £46,610; the area 472 acres; and a 1d. rate would produce £225. The application was to borrow £4,500 for thirty years for the purpose of laying new mains from the reservoir to the town. Since the [illegible] had been carrie[illegible] fullest supply of wat[illegible] proposed to lay a new [illegible] to the bullock market. Mr. F. Latham, borough surveyor, produced and [illegible] coming, the inspector said no doubt the Local Government Board would push the matter forward, and thus meet the wishes of all concerned.

Discovery of Manganese Deposits.

[illegible] line to the Orange River Colony and the Transvaal. [illegible] as any yet discovered in South Africa, and compares favourably with that obtained in Southern Russia and [illegible]

The Esneh Barrage.

[illegible] ment have decided to proceed with the construction of the Esneh barrage, and that the contract for this important undertaking has been entrusted to Messrs. John Aird and Co. The work will be commenced at once, the time being allowed for the completion of the [illegible] tion—a very important addition to the resources of the Government.

His M[illegible] Royal Commission on the subject of British canal communication.

Shipbuilding Returns.

[illegible] returns for 1905 show that the total output for the Tyne has been 357,000 tons, an increase of 77,000 tons over last year's returns. The Wear return shows 323,000 tons launched, an increase of 90,000 tons; West Hartlepool, 128,000 tons, an increase of 27,000 tons; the Tees, 143,000 tons, an increase of 28,000 tons; Blyth, 11,800 tons, an increase of 6,000 tons. According to the Glasgow Herald, the Clyde shipbuilding returns for 1905 show that the launches for the year numbered 319, and make an aggregate of 540,080 tons. Of the vessels thirty-six of 7,283 tons were non-propelling, and 283 of 532,797 tons were steamers. Only one of the non-propelling craft could be properly described as a sailing ship, this being the *Archibald Russell*, of 2,430 tons, built by Scott's Shipbuilding and Engineering Company, Ltd., Greenock, for Messrs. J. Hardie and Co., Glasgow. The others were all barges, lighters, etc.

Election of Members.

The following members of the North of England Institute of Mining and Mechanical Engineers: Mr. Ormsby Gore Adams, Thames, New Zealand; Mr. George A. Burton, Loftus, R.S.O., Yorkshire; Mr. Thomas Lewis Fryar, Toowoomba, Queensland, Australia; Mr. Thomas Hindson, Durham; Mr. Bennet Johnson, New Shildon, R.S.O., co. Durham; Mr. John Morgan, Crook, R.S.O., co. Durham; Mr. Arnold Carl Louis Olsen, Fordsburg, Transvaal; Mr. Glanville Reah, Gosforth, Newcastle-on-Tyne; Mr. John Roberts, Laxey, Isle of Man; Mr. William Pitt Welton, Wembley, R.S.O., Middlesex.

A Presentation.

At Handsworth, the foundry employees of Messrs. W. and T. Avery, Ltd., of Soho Foundry, presented a solid silver tea service, suitably inscribed, to Mr. Robert Buchanan (president of the British Foundrymen's Association) on the occasion of his leaving the employment of that company. Mr. Buchanan has been appointed joint managing director of Chamberlin and Hill, Ltd., of Chuckery Foundry, Walsall, and Phœnix Foundry, Lichfield, and he will also practise as a consultant on foundry matters. Mr. J. B. Tattersall, the new foundry manager in succession to Mr. Buchanan, occupied the chair, and about one hundred and fifty employees were present.

Machine Tools in Russia.

Consul Ernest L. Harris, of Chemnitz, states in a recent report that in consequence of the Russian tariff on foreign-made machines, French and Belgian manufacturers established branch machine factories in different parts of Russia, and the Saxon Machine Factory, of Chemnitz, in order to keep a grip upon the markets already won at an expense of years of patience and effort, also followed suit, and in 1896 built a large Russian factory upon an area of 148 acres of ground. The enterprise has been prosperous from the beginning. From 1897 to 1905, more than 700 locomotives have been made and delivered to the Russian railways. The war in the Far East has strained the factory to its utmost capacity. At the outbreak of the war the company made a contract with the Russian Government to deliver 102 locomotives within six months' time. During the present year the average output has been increased to twenty locomotives a month. In 1897 the factory was opened with 1,500 labourers. Since then that number has been increased to 4,000. There are few foreigners engaged in the factory, for the reason that it must be, and actually is for all practical purposes, entirely Russian in character.

The Mysore Mines.

The Mining Board and the various companies having been asked to suitably represent their industry at the Industrial and Agricultural Exhibition to be held in Mysore City on the occasion of the approaching Royal visit, the Kolar Gold Fields News reports the completion of the following arrangements: Nundydroog Company will contribute a map on a large scale of the whole underground workings from the Mysore mines to the Balaghat mine, also two models in gilded wood representing the total output of gold from the mines since their commencement in 1885 and the present annual output. Champion Reef and Mysore Companies will send specimens of quartz, sand, amalgam, sponge gold and bar gold, with samples of all the different sorts of instruments used in the process of extracting the metal from the flinty ore. A model of a poppet head and of the interior of a mill will also be sent, while Tank Block will contribute a ton of tailings and a ton of ore. Photos will be shown of underground and cyanide works, and of the various points of interest on the mine. Group photos will also be sent, showing, in comparison with modern scientific methods, natives at work in their primitive style extracting gold from the quartz by pounding it on a rock and panning the sand in water.

Proposed Congress of Capitals.

Sir Edwin Cornwall, chairman of the London County Council proposes a congress of capitals which would discuss such questions as lighting, tramways, street improvements, water supply, and education. He is of opinion that, if the representatives of all large capitals were in a position to compare notes and to arrive at conclusions based upon actual experience, many difficulties now meeting each municipality would be got rid of. The congress would meet at regular intervals in the different capitals.

ON THE TESTING OF CAST IRON AND OTHER MATERIALS BY THE EWING PERMEABILITY BRIDGE.

BEING A REPORT ON RESEARCH WORK CARRIED OUT AT THE NATIONAL PHYSICAL LABORATORY.

By Albert Campbell, B.A.

THE [illegible] was undertaken with [illegible] a suitable method of testing bars of widely different magnetic properties by means of an Ewing Permeability Bridge. The research was carried out in the National Physical Laboratory, at the desire of the director, who has taken constant interest in the progress of the experiments. It was felt that the magnetic testing of cast-iron was of considerable practical importance, and also that in connection with the metallurgical work of the laboratory, magnetic tests on rods of various alloys were sometimes required. The bridge, as Professor Ewing has pointed out, was intended for the comparison of bars of somewhat similar quality, and has been used with success for such comparisons in some of the experiments detailed below. Professor Ewing informs us that the soft-iron standard supplied with the instrument is only suitable for the usual work of testing iron for dynamos, magnets, etc. (of nearly carbonless steel or forged iron). It was necessary, therefore, to provide and calibrate a series of standards near in magnetic quality to the cast-iron and other materials to be tested. The general scheme of experimenting was as follows: A number of standard test pieces were prepared from materials covering a range of magnetic quality as wide as possible; their magnetic curves were determined by Ewing's small yoke method, and finally they were compared in various ways by the permeability bridge. For the sake of clearness in what follows, I shall say a few words on the usual working of these methods, referring the reader for further details to Professor Ewing's book, "Magnetic Induction in Iron and Other Metals" (3rd edition).

In the Small Yoke Method the two similar bars have a magnetising coil and a secondary coil slipped over each, and are then united to form a closed magnetic circuit by two small yokes consisting of blocks of iron clamped to the bars. Two sets of ballistic readings are taken with this circuit: (1) with a clear length [illegible] centimetres, and (2) with the clear length reduced to 2π centimetres. If H' be the value of $\frac{4\pi C_1 N_1}{l}$ in case (1) and H'' be its value in case (2), Professor Ewing has shown that the correction for the yoke reluctance (to be subtracted from H') is equal to H'—H'. The correction is most easily applied by drawing H'—B and H''—B curves.

MATERIALS OF STANDARD TEST PIECES.

The materials used comprised the following: Soft iron, mild steel, tool steel, cast-iron, and one of Heusler's alloys. Of these, the soft iron was the pair of standard rods supplied with the instrument; the cast-iron was obtained from several different foundries; whilst the specimens of Heusler's alloy were made in the metallurgical department by Mr. Longmuir.* The last-named alloy consisted of copper, manganese, and aluminium in the proportions roughly of 62 [illegible] aimed at poor magnetic qualities.

As it was found that the permeability curves obtained for bars of the above materials did not form a sufficiently complete series, the following method of filling in the gaps was tried, and proved quite successful. In addition to bars of the standard dimensions, pairs of *tubes* were constructed of the same outside diameter as the bars and of various sizes of bore. Seamless steel tube was found very convenient for some of the sizes. The two heaviest pairs of tubes, however, had to be bored out of the solid. It was also found possible to adjust the cross-sections of the tubes by filing a flat all along the length. Two pairs of the tubes were treated in this way, and, when care was taken in placing them in the clamps, no abnormality was noticed in their behaviour. All the tubes were tested in the same way as the bars, the apparent permeabilities corresponding to the standard cross-section being determined. Thus the tubes afforded a series of what might be called "diluted" permeabilities.

---

* Heusler's [illegible] composed of metals which [illegible] themselves [illegible] properties and yet some [illegible] alloys are as [illegible]

W[illegible] "apparent" flux density B, [illegible] [illegible]ed by the sectional area of a bar [illegible] [illegible].

TESTS BY THE SMALL YOKE METHOD.

[illegible] or tubes in each pair were chosen to match each other as well as possible, and for this [illegible] compared for equality in the bridge [illegible] several cases the agreement was practically exact [illegible] for some of the materials I had to be content with pairs which differed at some points of their curves by 3 to 4 per cent. in H (for the same B). After this process of matching, each pair was tested by Ewing's small yoke method. When the bars do not differ much, it may be assumed that this method will tend to strike the average value for the pair. The curves had a small correction applied on account of the area of the secondary winding being considerably greater than the cross-section of the bar. (Even at H = 100 the correction applied to B is only about 40.)

TESTS ON RINGS.

In order as far as possible to corroborate the results obtained for the rods and tubes with the small yokes, a number of tests were made by the ordinary ballistic method upon rings of some of the materials. As it is a very difficult matter to ensure that rings and rods shall be identical in magnetic quality, the results of two sets of these tests seem of sufficient interest to be given in detail.

SET 1.—CAST IRON.

A bar was cast of diameter 3 cm. and length 50 cm., and in the same box with it there was cast at the same time a ring of about 12 cm. mean diameter. This ring was turned down to suitable thickness for the ballistic tests (the cross-section being about 1 sq. cm.), and from the rod were turned two bars for the yoke method [illegible] mm. diameter, and two small rings of 2·4 cm. mean diameter, one of them being cut longitudinally and the other circumferentially from the large bar. These were all tested without annealing, and the results are shown in the curves of fig. 1. It will be noticed that the H—B curve for the large ring lies between those for the two small ones, while, as would be expected, the ring cut longitudinally shows fair agreement with the two rods. The general agreement here appears to give a good amount of support to the accuracy of the small yoke method.

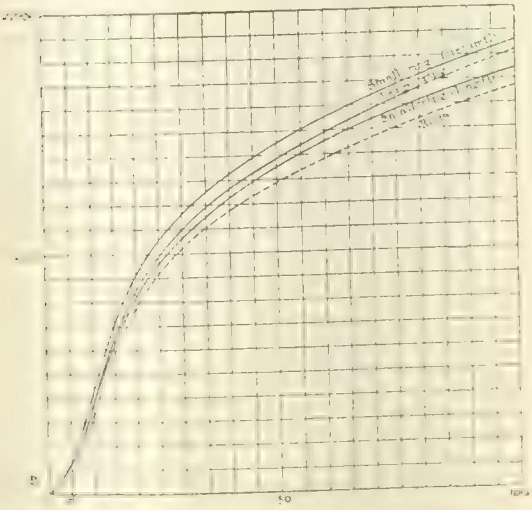


Fig. 1.—Cast-iron Rods and Rings cast together.

SET 2. MILD STEEL.

Very small rings were obtained by cutting short pieces off the mild steel tubes. To give an idea of their smallness fig. 2 shows end views

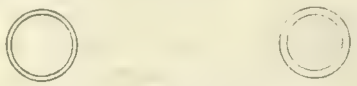
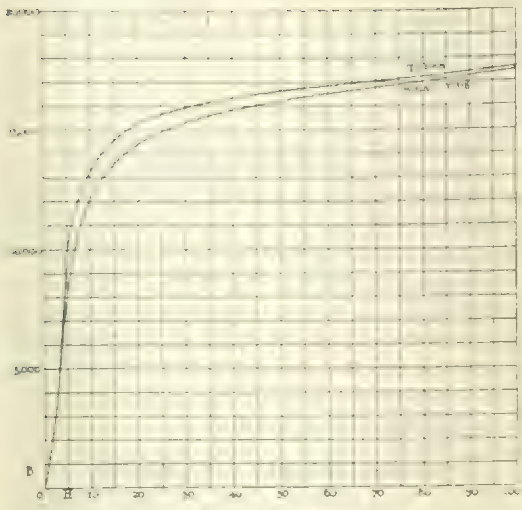


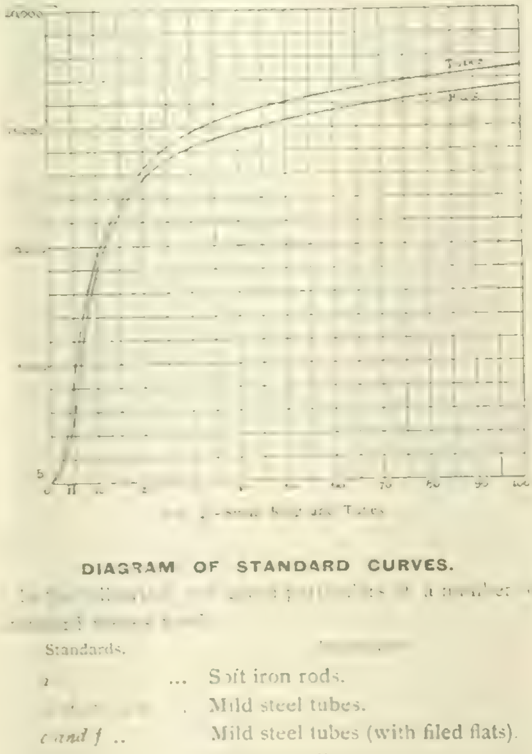
FIG. 2.—Small Rings (full size).

of two of them drawn to full size, their walls being about 0·6 and 0·9 mm. thick respectively. Each ring was insulated with silk and wound with 50 turns of fine insulated wire to form the secondary winding. As the inside diameter was very small, being only 7 or 8 mm., very little space was left for the winding to carry the magnetising current. It was found by experiment, however, that a sufficiently uniform H could be obtained by making the primary winding in the form of a sheaf of eight or ten insulated wires quite filling the inside of the ring, and straight for about 5 cm. on either side. The distribution of the return paths of these wires appeared to be almost immaterial to the result. By making the ballistic tests very quickly, it was found possible to run the current density in this primary winding as high as 2,500 amperes per sq. cm. (15,000 amperes per sq. inch) without undue heating, and thus values of H as high as 100 were attained. Two sets of results are shown in figs. 3 and 4; in these the curves for the tubes show the *real* (not "apparent") values of B calculated for the actual section of the iron. In the first set (fig. 3) the ring and tubes had been annealed together (at 800° C.), while in the second (fig. 4) the material was in the condition in which it was received from the makers.

The agreement here shown between the curves for the rings and the tubes (particularly for those annealed together) seems almost as close as could be expected, and hence forms additional evidence in favour of the small yoke method.



[illegible] annealed together



[illegible] Tubes

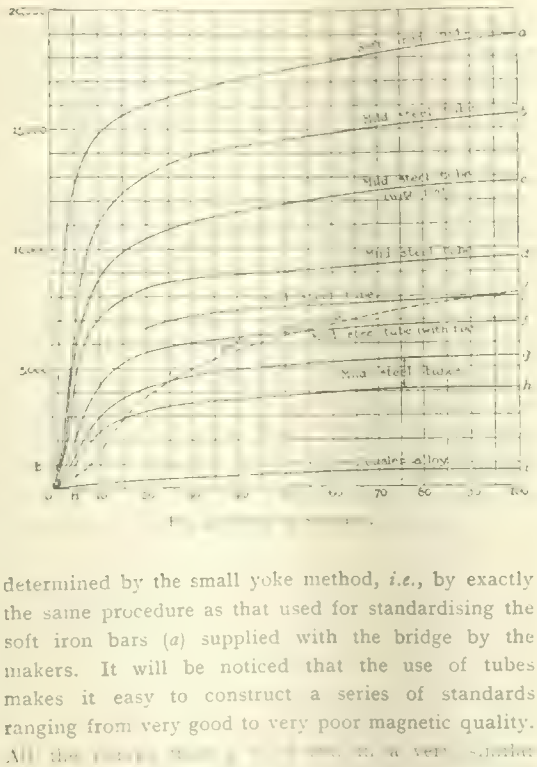
DIAGRAM OF STANDARD CURVES.

[illegible]

Standards.	[illegible]
a ...	Soft iron rods.
[illegible]	Mild steel tubes.
e and f ..	Mild steel tubes (with filed flats).
i	Heusler's alloy.
[illegible]	Tool steel rods.
n	[illegible] (annealed)
[illegible]	Cast-iron rods (annealed).
[illegible]	[illegible]
[illegible] —	[illegible] tubes [illegible]

For each pair of these standard pieces tests by the [illegible] viz. (1), the H'—B_1 [illegible] H' is the apparent value of the [illegible] ([illegible]) observed for the [illegible] length of the rods not connected for the yokes, and B_1 is the apparent flux-density, assuming the cross-section of the bar to be of standard size; (2) the H—B_1 curve, where H has the corrected value found in the usual manner by testing the rods also at half length.

The H—B_1 [illegible] of the [illegible] pieces are shown in fig. 5, each curve having been determined by the small yoke method, *i.e.*, by exactly the same procedure as that used for standardising the soft iron bars (*a*) supplied with the bridge by the makers. It will be noticed that the use of tubes makes it easy to construct a series of standards ranging from very good to very poor magnetic quality. All the [illegible] in a very similar manner. In striking contrast to these is the curve *q* which is for annealed cast-iron rod (also by the small yoke method). To each of these curves there corresponds an H'—B_1 curve. This second series of curves is wanted for the method of crossing points described below, but for clearness I have omitted it from fig. 5. After their curves had been determined by the small yoke method some of the standard bars were then compared with one another (by the ordinary method) in the permeability bridge. Two examples of this intercomparison will be sufficient to indicate the general nature of the results obtained; these are shown in fig. 6. In this figure the curves *d*, *g* and *h* are the H—B_1 curves for three of the tube standards, whilst the dotted curves g_1 and g_2 show the apparent curves obtained for tube *g* by testing it in the bridge



[illegible]

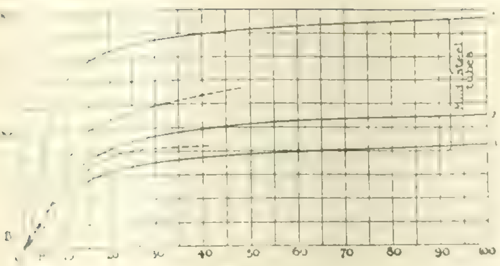


Fig. 6

[illegible] and e respectively, and using the H [illegible] already drawn for *d* and *h*. It will be noticed that both of these dotted curves are considerably in error from the true curve *g*, the instrument showing a tendency to bring the curve of the test piece too near that of the standard in each case. Similar results were found with solid rods. It is quite clear, therefore, that samples with curves as far apart as *d*, *g* and *h* cannot be successfully compared with one another by the ordinary use of the bridge.

METHOD OF CROSSING POINTS.

The difficulty can be surmounted to a great extent, however, by using the bridge mainly for testing exact magnetic equality, in other words to determine the respective points at which the H^1—B_1 curve of the test piece crosses each of the standard H^1—B_1 curves. By arranging that the curves shall not cut one another too obliquely, it is easy to determine these crossing points with good accuracy. The practical procedure is as follows: The bridge is set with equal numbers of turns (say 200 for each bar), the test piece and the lowest standard are placed in the clamps, and after demagnetising if necessary, the magnetising current constantly commutated is gradually raised from a lower value, until an exact balance is obtained. The value of the current for which this occurs gives the H^1 for the first crossing point; by replacing the first standard by the next higher one, and continually raising the current, another point is found, and so on until a sufficient number of points is obtained. When the standards are suitably selected it will usually be found that no more than two or three crossing points are required to give, with sufficient accuracy, the part of the unknown curve that is of importance in practice. The intermediate curves of the series shown in fig. 5 cover a range suitable for testing various kinds of cast iron. It will be noticed that the crossing points thus found are only points on the curve uncorrected for the reluctance of the yokes and joints. To [illegible] ding point on the H—B_1 curve [illegible], the value of (H—H) [illegible] this we have no choice but to assume this correction to be the same in the bridge as it is in the small yokes. Again, since at a "crossing point" an exact magnetic balance is obtained, we may reasonably assume this correction to be the same in the tested bar as for the standard. From the two sets of curves (1) and (2) already mentioned (H^1—H) is known for all the standards, and thus the corrections might be applied. But I have found that the following easier method gives somewhat better agreement with the experimental results. The values of (H^1—H) corresponding to $B_1 = 1{,}000$, 2,000, 3,000, and so on, were tabulated for a variety of different rods and tubes, and an average struck for each value of B_1; the mean values of (H^1—H) thus obtained were used as the corrections in what follows.

TESTING ACCURACY OF METHOD.

In order to test the accuracy of the method of crossing points, several pairs of cast-iron and tool-steel rods and tubes (both with and without annealing) were tested by the small yoke method and their curves drawn. When the crossing points were observed, nearly all of them were found to be in very fair agreement with these curves. For example, in fig. 7 the curves *p*, *q* and *r* were obtained for cast-iron rods and tubes by the small yoke method, while the small crosses (x x x) show crossing points found independently by testing the same specimens against each of the standard tubes *e*, *f*, *g* and *h*. The curves *m* and *n* were similarly found for tool-steel rods (without and with annealing respectively), and the small circles (⊙ ⊙ ⊙) show crossing points with the standards. For the last two curves, *m* and *n*, the crossing points at H = 30 are considerably off the line. The discrepancy does not seem to be due to errors of observation, for the tests, when repeated showed the same results.

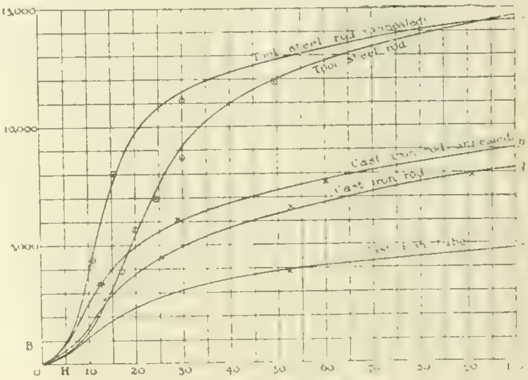


Fig. 7.—Tests by Crossing Points.

ADDITIONS TO SERIES OF STANDARDS.

The cast-iron and tool-steel pieces of fig. 7 are also useful as additions to the series of available standards, and in some instances one of the standards may be similar enough to the tested piece to allow of the bridge being used in the ordinary way, but in all cases the H—B curves of the standards should be used instead of the corrected H—B curves which are commonly employed. It may be of interest to mention that the various materials compared in the bridge were very different among themselves in the matter of time lag of magnetisation. It is well-known, for example, that soft iron and mild steel show this effect strongly.* In many of the comparisons the difference of time lag showed itself very clearly by causing the needle of the bridge magnetometer to give a violent throw and then settle down to a steady position. In all the experiments this initial throw was disregarded,† and the balance was obtained by reducing to zero the steady displacement. It seems quite possible that the large differences in magnetic lag may account for some of the crossing points not lying quite on the curves obtained with the ballistic galvanometer (whose complete period was about 8·5 seconds.

The results given in this paper are only a part of a larger series actually obtained; tests were made on about 100 pieces in all. Most of these test pieces were made under the superintendence of Mr. Jakeman, to whom I would here express my best thanks. My thanks are also due to Dr. Carpenter and Mr. Longmuir for their kind help in the preparation and annealing of some of the specimens.

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* [illegible] see [illegible] Bulletin de la [illegible] No. 40, 1909.

† [illegible] clearly pointed [illegible] on the instrument.

[illegible] in [illegible] Electrical Engineers.

ELECTRIFICATION OF THE NEW YORK CITY TERMINAL OF THE NEW YORK CENTRAL R. R.

[illegible] River Railroad is now making extensive changes in a total of fifty-one miles of its line that will result in the entire elimination of steam motive power from that portion of the road and the substitution therefor of electric motor-cars and electric locomotives. This work has been under way for three years past, and the magnitude of the enterprise, as it now nears completion, makes it one of the largest engineering operations in America.

The following details are gleaned from the Railway [illegible] two power [illegible] will [illegible] electric power required. One of these is at Port Morris on the water front of the East river, near Mott Haven; the other is at Yonkers, on the Hudson divisions. Both are situated on navigable waters, and the intention is to receive the coal supply direct from [illegible] rail [illegible] needed.

In size, general arrangement and equipment the two stations are similar. The main building of each is 167 ft. by 237 ft., and 105 ft. high. Relative to the capacity, 30,000 kilowatts, each station has an area of 1·32 square feet per kilowatt, and a volume in the main building of 102 cubic feet per kilowatt. The framework is of steel, designed so as to have no inaccessible surfaces; the walls are of brick and tile; the floors are of concrete; and the roofs are of concrete roofing slabs covered with copper with standing seam joints. Structural steel to the amount of 2,800 tons will be used in each power house.

The maximum coal consumption at the power stations will be about 220 tons per day. A brick wall divides the building, forming two large rooms: the boiler-room, 88 ft. by 231 ft. 8 in., and the turbine-room, 69 ft. by 231 ft. 8 in. The turbine-room is open to the roof, but the upper portion of the boiler-room is filled by coal bunkers of 3,500 tons capacity.

The equipment of each boiler-room is to include twenty-four Babcock and Wilcox water-tube boilers rated at 625 h.p., located twelve on each side of a central alley. The initial equipment will be only sixteen boilers. The total heating surface of each boiler is 6,250 square feet, and the grate surface is 112 square feet, giving a ratio of 55·8. The boilers are designed for a normal working pressure of 185 lb., and the steam will be used at 200 deg. of superheat. The superheaters are arranged inside the boiler setting, and each is made up of 168 2 in. tubes, each 13 ft. 5 in., in length, giving a total of 1,230 square feet of heating surface.

Each turbine-room is to have accommodation for six 5,000-kilowatt turbo-generators, but only four will be installed for the initial equipment. The turbines are of the Curtis five-stage, vertical type, and are 15 ft. diameter at the base and 35 ft. high from the floor to the top of the generator.

The generators each have a capacity of 5,000 kilowatts, and are wound for three-phase current of 25 cycles and 11,000 volts pressure. Current will be distributed by a high-tension transmission system to eight substations located along the line. The wires are carried overhead except through closely settled districts where underground conduit is used.

SHIPBUILDING NOTES.

THE annual statement of the Registrar of Shipping, [illegible] a few days ago, shows that during November 61 steamers were added to the registries of the United Kingdom, with the heavy gross tonnage of 150,315. Four of the steamers were over 7,000 tons each, including the new turbine steamer *Carmania*, of [illegible] tons. About 43 steamers were removed from the registers, with a tonnage of nearly 70,000 tons. A further selection from the annual returns of the more important shipbuilding appears below.

Messrs. Wm. Simons and Co., Ltd., Renfrew, launched recently a light-draft twin-screw suction hopper dredger, named the *Tethys*, built to the order of

HENRY SCARR, HESSLE.

[illegible]	Wood, iron, or steel	Steam or Sail.	Port.	Gross Tonnage Register.	Engines.
[illegible]	Steel	Sail keel	Hull	[illegible]	—
[illegible]		Sail keel		[illegible]	—
[illegible]		Sail keel		120	
[illegible]		Steam tug		80	200 b.h.p.
Eagle		Steam barge		[illegible]	140 b.h.p.
[illegible]		Towing barge		[illegible]	—
Lizzie		Towing barge		[illegible]	

RAMAGE AND FERGUSON, LTD., LEITH.

Name.	Material.	Description.	Gross Tonnage.	I.H.P.	Engines.	Owners.
Honor	Steel	Steam yacht	916	1,400	Twin, triple	British.
[illegible]		Screw steamer	987	1,000	Triple	
[illegible]		Steam yacht	577	900		
[illegible]		Salvage screw steamer	[illegible]	700	Twin, compound	
[illegible]		,,	567	1,000	Triple	
		Total	3,498	5,000		

WORKMAN, CLARK AND COMPANY, LTD.

[illegible]	Material.	Steam or Sail.	Port of Registry.	Board of Trade Gross Tonnage.	Gross Tonnage including Erections.	I.H.P.
[illegible]	Steel	Steam	Liverpool	[illegible]	[illegible]	[illegible]
City of Karachi			,,	[illegible]	6,010	[illegible]
[illegible]			Belfast	8,050	8,050	7,500
Patani			Liverpool	[illegible]	4,840	2,800
[illegible]				3,400	4,840	2,800
[illegible]			Belfast	3,800	[illegible]	[illegible]
Zent				3,800	[illegible]	[illegible]
Orator			Liverpool	[illegible]	[illegible]	[illegible]
[illegible]			Glasgow	2,090	2,090	[illegible]
[illegible]			Liverpool	9,100	[illegible]	5,200
[illegible]			,,	7,200	9,000	3,600
[illegible]			Glasgow	2,500	2,600	2,500
				58,190	64,140	[illegible]

[illegible] removal [illegible] Wales seaboard. This vessel has been specially designed by the builders for work in shallow rivers, her load draft being 6 ft.; the forefoot is well cut away to facilitate rapid turning. Two independent sets of triple-expansion engines are fitted for propelling the vessel at a speed of about 10 knots per [illegible] two Babcock and Wilcox water-tube boilers, constructed for a working pressure of 200 lb. per square inch. Two powerful sand dredging pumps are provided, each driven by an independent set of triple-expansion engines, and each connected to separate suction pipes, one on either side of dredger looking aft, and arranged to dredge when the vessel is steaming slowly [illegible].

HARLAND AND WOLFF

Name.	Description.	Port.	[illegible] Tonnage.	I.H.P.	Engines.
[illegible]	Steel, twin screw	Belfast	[illegible]	[illegible]	4-cylinder balanced.
Bologna	.. ..	Genoa	4,603	[illegible]	Triple.
[illegible]	.. ..	Hamburg ..	[illegible]	[illegible]	4-cylinder balanced.
Mahronda ..	Steel, single screw	Liverpool ..	[illegible]	[illegible]	
[illegible]	Steel, twin screw	Dublin	[illegible]	[illegible]	
[illegible]	.. ..	Liverpool ..	[illegible]	4,886	
[illegible]	.. .. ..	Rotterdam	17,250	[illegible]	
Malakand ..	Steel, single screw	Liverpool ..	[illegible]	[illegible]	
[illegible]	.. ..	,,	[illegible]	[illegible]	
[illegible]	H.M. first-class battleship (Machinery only) ..			[illegible]	
		Total	[illegible]		

THE DUBLIN DOCKYARD COMPANY

Names.	Sail, Screw, or Paddle.	British or Foreign.	Board of Trade Gross Tonnage.
Shellie .,	Single screw	British	360
Shamrock ..	[illegible] screw		4[illegible]
Six steel barges ..	—		[illegible]
Four motor launches	—		[illegible]

JOHN CRAN AND CO., LEITH.

Vessels Built.

Name.	Tons.	Description.	Registry.
[illegible]	2[illegible]	Steel screw tug	Liverpool.
Canning	148	Steel screw tug	[illegible]
No. 53	[illegible]	Steel barge	Foreign.
[illegible]	[illegible]	Steel screw lighter	Carron Company, Grangemouth.
Luisara ..	[illegible]	Steel screw tug and passenger tender	[illegible] America.
	[illegible]		

Vessels engined.

Name	H.P.	[illegible]
Steam tug *Herculaneum*	[illegible]	Compound
Canning	7[illegible]	
[illegible]	[illegible]	
	[illegible]	

Work on hand.

Two new steel screw tugs, each 150 tons and 705 h.p.

ALLEY AND MACLELLAN, LTD.

[illegible]	[illegible]	Board of Trade Gross Tonnage.	I.H.P.	Owners.
Hopper barge	Steel	[illegible]	—	Foreign.
Cargo barge ..		[illegible]	—	
Screw steamers		340	[illegible]	
Paddle steamers		[illegible]	[illegible]	
Screw steamers		[illegible]	[illegible]	
Screw dredger		[illegible]	[illegible]	
Twin-screw steamer		[illegible]	[illegible]	
		[illegible]	[illegible]	

1905.

Screw steamers	[illegible]	53	[illegible]	
Cargo barge ..		[illegible]	—	
Stern wheel steamer		[illegible]	[illegible]	
		1,330	250	
Cargo barge ..		11	—	
Stern wheel steamers		270	[illegible]	
Cargo barges		[illegible]		
Screw steamers		132	320	
Cargo barges		450	—	
		870		
		2,853	1,380	

IN HAND.

Stern wheel steamer	Steel	[illegible]	[illegible]	
		133	250	,,
Cargo barges		240	—	
Screw steamer		230	200	

LIST OF VESSELS ENGINED BY JOHN G. KINCAID AND CO., OF CLYDE FOUNDRY, GREENOCK, DURING 1905.

[illegible] Type of Vessel.	Type of Engines.	I.H.P.	Shipbuilders.
s.s. *Francesca*, single screw cargo and emigrant steamer	Triple expansion ..	[illegible]	Russell and Co., Port Glasgow.
s.s. *Carolina*, single screw cargo steamer		[illegible]	
s.s. *Ben Nevis*, single screw cargo steamer		[illegible]	
s.s. *Ben Vrackie*, single screw cargo steamer		[illegible]	
s.s. *River Clyde*, single screw cargo steamer		[illegible]	
s.s. *Menepthah*, single screw cargo and passenger steamer		[illegible]	A. McMillan and Son, Dumbarton.
s.s. *Garscube*, single screw cargo steamer		[illegible]	
s.s. *Loke*, single screw cargo steamer ..	..	[illegible]	Campbeltown Shipbuilding Company.
s.s. *Gretavale*, single screw cargo steamer		[illegible]	Grangemouth and Greenock Dockyard Company.
s.s. *Cruz de Malta*, twin screw cargo and passenger steamer		[illegible]	
[illegible] single screw cargo [illegible]		[illegible]	
	Total .	[illegible]	

I.H.P. in 1905	[illegible]		
I.H.P. in 1904	[illegible]	Increase in 1905 .	[illegible]

SOME CONSIDERATIONS IN THE EQUIPMENT OF INCLINE SHAFTS.

By F. N. HAMLEY.

THE first problem that confronts a mining engineer in the exploitation of a reef proposition is, firstly, the particular class of shaft to be adopted, and secondly its location. I am assuming that such a proposal has come before an engineer, and it has been decided that the property is to be opened and worked through inclined shafts. The mining regulations call for two independent outlets from any one mine. To make my subsequent deductions clearer, I will make the following assumption :—

1. The property to be developed has a claim area in which it is estimated that on a milling basis of 200 stamps crushing six tons per day, a life of ten years will be obtained, this figure of ten years being calculated as the minimum for a fair depreciation of plant, and most consistent with its present value standing.

2. Sorting 20 per cent. of the ore mined. The tons to be mined therefore per working day, allowing for 20 per cent. sorting, and a crushing capacity of six tons per stamp, and taking 26 working days per month, amounts to 1,730 tons.

3. Two years' supply of ore to be developed before milling is started.

The case resolves itself, therefore, into one in which two shafts must be provided to comply with the mining laws through which to feed the number of stamps given 1,730 tons of milling rock, plus that broken in shaft-sinking and development faces, have to be hauled per day.

The first consideration arising out of the problem is whether one of these shafts be made large enough to do the whole of the mill-hoisting work, making the other correspondingly smaller, and using it only as a travelling and air-way and for hoisting development rock ; or, as an alternative scheme, shall each of the two shafts be made of equal size and be similarly equipped, each being capable of handling, say, two-thirds or all of the rock required for the mill. I consider the first of these two propositions to be the best for the following reasons : 1. Less capital cost, and 2. less working cost, which statement appears so self-evident as not to require any burden of further support.

The chief objection to the one hauling shaft proposition is that in case of a breakdown in the main haulage shaft, we are faced with the

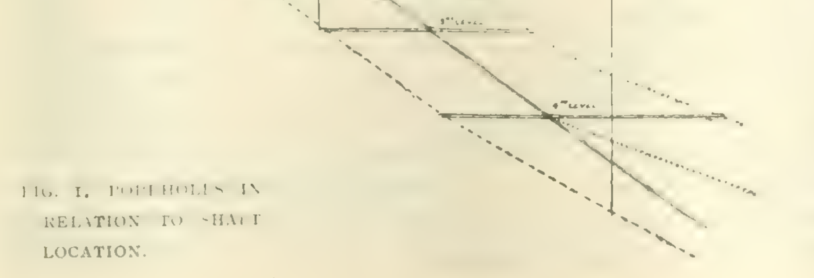


FIG. 1. BOREHOLES IN RELATION TO SHAFT LOCATION.

possibility of the whole mill being hung up. W[illegible] shafts this possibility [illegible] course, practically annulled. If, however, great care is taken in the general equipment of the one main hauling shaft, it is possible to reduce the chance of a breakdown to such an extent as to make it for all practical purposes negligible, hence the economic advantages both in first cost and subsequent working costs are in nowise minimised. Involved in this argument, amongst many other points, are the following:

1. Size and grade of shaft;
2. Headgear bins;
3. Skips;
4. Tracks;
5. Ore bins underground.

It is to these important sections that I propose to draw attention, particularly bearing on the question of ore supply to the mill. It will be admitted, I think, without question, that the first aim of every mine manager is to keep his mill running uninterruptedly. Stoppages are losses—and irrecoverable losses—and the monthly statement of revenue and expenditure is always adversely affected in due proportion to the mill stoppages. At the same time, a mill may be kept running continuously on ore which has been put into the mill bins in such a manner and at such a cost as to still leave possibilities for improvements undeveloped. These possibilities of improvement are considerably wrapped up in the arrangement and size of the underground ore bins, since if these arrangements are bad, all the waste rock must be sent to the mill. Other features inimical to good work are the following: Small size of ore bins and the consequent necessity of changing continuously from bin to bin in the shaft, by which valuable time is lost; grizzleys being too widely spaced; chutes and doors arranged in such a way as to make the speedy filling of skips an impossibility, as well as requiring more more labour than is otherwise necessary: stopes blocked with ore whilst shovel and tram boys stand idle because the small shaft bins are unable to receive the ore; rails in the shaft both too light and badly laid; skips too small and badly designed for fast running. All these factors tend to inefficiency of labour, high maintenance costs, and low efficiency from machinery.

I now propose to indicate some arrangements to improve upon or eliminate the unsatisfactory conditions outlined above, and shall discuss these questions in the order laid down.

SIZE AND GRADE OF SHAFT.

With a one hauling shaft proposition, bearing in mind the amount of ore and waste rock to be raised, in this particular proposition, together with material, stores, etc., to be lowered, the following are the sizes and number of compartments I would suggest. Four hauling ways, one sinking way and one pump and ladder way of the following dimensions in the clear. Hauling and sinking ways 5 ft. 6 in. by 6 ft. Pump and ladder way 5 ft. 6 in. by 7 ft. The travelling and air shaft to be sunk in connection with the main hauling shaft would be a small three-compartment shaft, the size of the compartments being 4 ft. 6 in. by 5 ft.

In the two hauling shaft proposition, each of the shafts should contain four compartments, consisting of two hauling ways, one sinking way, and a pump and ladder way, the sizes of these various compartments being the same as in the main hauling way in the first proposition.

With regard to the grade at which the shaft is sunk, it is usual to more or less follow the dip of the reef. This practice is frequently attended with a considerable difficulty, in some cases made impossible, by faulting of the reef, and in many instances it has come to my notice on these fields that a shaft which has been started on reef with the intention of sinking on the reef, has through faulting been carried either considerably under or over same, which has necessitated expensive cross-cuts from the stations to the reef. In many instances one or two prospecting boreholes put down from the surface at, say, one-third and two-thirds of the distance from outcrop to the boundary would indicate the position of the reef at these points. With this knowledge, in case faulting is proved, the shaft can be carried down at an even grade, and the amount of cross-cutting reduced to a minimum. I have constructed a diagram (fig. 1) which illustrates graphically two conditions, in each of which a considerable amount of money would have been saved if boring had first been carried out before shaft sinking had been done. In the case of an incline shaft, which it is found necessary to alter to a flatter angle to conform to the dip of the formation, I have found that if the width of the shaft be slightly increased in that portion of the shaft occupied by the curve employed in reducing the angle of inclination, the fixing and maintenance of the rope carrying rollers is very much simplified, and comparatively large diameter rollers can be put in. I show a sketch (fig. 2) of this arrangement as fixed in the New Goch incline shaft.

The radius of the curve employed should be designed to allow the skips to be hoisted through it at a maximum speed for which the shaft equipment is designed. Any diminution of the speed of the skips which would be necessary if the radius were too small, wears out the rope on the headgear pulleys and the brakes on the [illegible] addition to the loss of time involved.

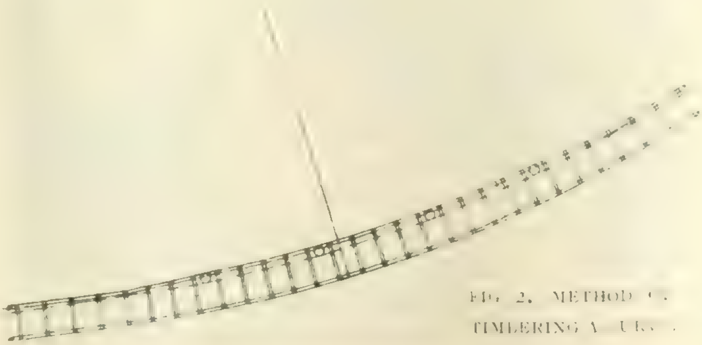


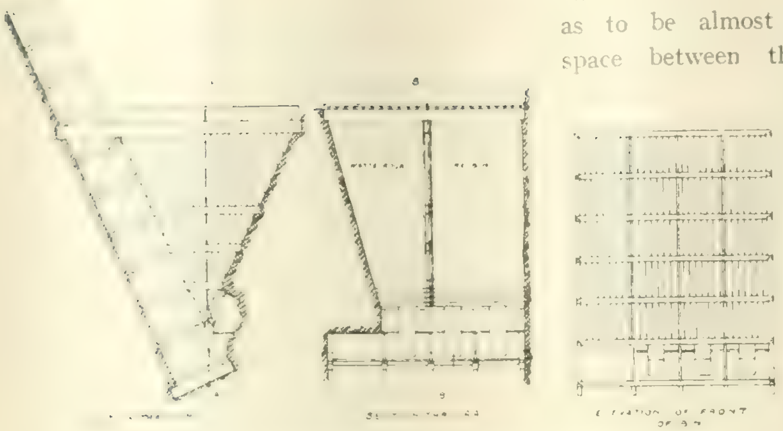
FIG. 2. METHOD OF TIMBERING A CURVE.

HEADGEAR BINS.

[illegible] referred to, the principal point to my mind to be studied when designing same, is the storage capacity. For a proposition such as we have outlined, where 1,730 tons of ore, in addition to waste rock, has to pass the headgear bin daily, I consider their capacity should be equal to at least one-third of this amount, in order to give a stand-by should anything go wrong during the day with the surface transport arrangements. It is usual to provide some tipping arrangement in the headgear just above the collar of the shaft, by which drills can be dumped out of the skips at surface. If this arrangement is fitted to all the tracks, it can be brought into use when water is being hoisted, and the water dumped at a point from which it can be readily taken away. There is a strong objection to dumping water into the headgear bins, more particularly if the headgear is a wooden structure.

SKIPS

The size and design of skips, when combined with the capacity of ore bins and the condition of the track, bears a very important part in the economy of hoisting. For the size of the shaft I have indicated, I should put in a skip of sufficient capacity to hold six tons of broken rock and hauling engines capable of lifting these skips unbalanced, from the ultimate depth of the shaft and to attain a speed of 2,500 ft. per minute. These skips should be designed with the object of providing for smooth running at the speed above indicated. If reliable self-lubricating bearings are put in it is quite possible to run this size of skip up to a speed of 2,500 ft. per minute with 15-in. wheels, without the maintenance [illegible] unduly high. In the



[illegible] FRONT AND SECTIONAL ELEVATIONS OF UNDERGROUND ORE AND WASTE ROCK BINS.

case of a breakdown of the pumping arrangements, involving the necessity of hauling water, each of the skips should be provided with a clack, and arrangements made for dumping water on surface clear of the headgear. Whilst on the subject of hoisting water by skips, I might mention that at the New Goch Mine the pump sumps are connected at their lowest point with a cross-cut from the shaft. A pipe is laid through the cross-cut from the bottom of the sump, and a hose arrangement fixed, whereby the water in the sump can be run directly into any of the skips. This is a useful arrangement when the necessity of cleaning out the sumps occurs.

TRACKS.

To hoist a skip containing six tons of ore at a speed of 2,500 ft. per minute, the rails must be of heavy section, and great care taken in laying them down. The weight of the rails should be at least 65 lb. per yard, and I do not consider 80 lb. too heavy. These should be fixed to the sills by coach screws through the flanges in addition to the usual dog spikes. At the New Goch incline shaft, 80-lb. rails have been installed and fixed in the above manner. The joints on either side of the track do not come opposite each other, and the ends of the rails are brought so closely together as to be almost touching. The inevitable space between the sills and the foot wall rock of the shaft has been filled solid with concrete. With the sills spaced about 5 ft. a track is obtained over which the maximum speed can be attained with great safety.

The ballasting of the sills with concrete serves also as a drain by which any water making in the shaft can be led, at the point of inflow to the shaft, directly to the pump way, thus preventing to a large degree, acid water coming into contact with the rails and winding ropes.

ORE BINS UNDERGROUND.

The points to be observed in laying out the underground ore bins are (*a*) capacity, (*b*) division, (*c*) grizzleys, (*d*) discharge chutes and doors, and (*e*) type and cost.

(A) *Capacity.*—The capacity of an ore bin should bear a definite relation to the milling capacity and the length of the backs underground. In the proposition I have indicated by the time two years' supply of ore will be in sight, assuming backs of 250 ft., four levels will be opened up, and the ore bin equipment completed. Each of these four ore binswill, therefore, be called on to hold at least one-fourth of a day's supply of ore for the mill, which would equal, say, 450 tons. In addition to this ore capacity, each bin should be also arranged to hold, say, 100 tons of waste, making the total capacity of the bin 550 tons. With 450 tons of ore in each box, and six-ton skips, averaging 25 trips per hour—which allows ample time for filling, hoisting, and tipping—the two hoisting engines can easily handle the 1,730 tons required daily for the mill, working on an average of six hours per day. To enable the whole of this ore to be put into the mill during the day shift only, this would probably be the method adopted, and the ore bins would necessarily have to be of ample capacity to hold a sufficient reserve of ore trammed during the night shift, to enable steady and continuous running being made when the hoisting engines start work. With 200 tons in each of the four bins when hoisting is started it would probably not be necessary for either engine to change from one bin to the other more than three times in each shift.

(B) *Division.*—Each bin should be divided into two unequal compartments. The small compartment situated over the sinking way, should be designed to hold, as above indicated, about 100 tons. This would hold the waste rock from about 50 ft. of driving, and should allow storage room for the rock from four days' development work on ten faces. To illustrate the importance of making provision for keeping waste rock and unpayable ore separate from payable ore underground by the provision of waste and ore compartments in the ore bins, I have figured that during the development period when the two years' supply of ore for the mill is being opened up, assuming that the development is being carried on two reefs, the average stope width of which will be 50 in., that 70 per cent. of the ore is payable, and that through faulting 30 per cent. of the driving is off the reef, the total footage driven will be 25,391, of which 7,617 will be off the reef. The actual tonnage broken in the drives will be roughly 51,000, of which a little more than half, say, 26,000 tons, will consist of waste and unpayable ore. If this waste and unpayable ore is dumped into the same bin with the payable ore, the probabilities are that if this is subsequently put through the mill, a considerable difference will be shown in the profit obtained compared with that if the payable ore had been kept separate from the waste. To illustrate this, I will assume that the payable ore is valued at 6 dwt. and the waste and unpayable ore at 1 dwt., and that the breaking and hoisting of this rock being already charged to development, reduction costs only will be charged against the revenue obtained from it. The total tonnage of 51,000 tons put through the reduction works would yield a recovery of about 12s. at a cost of, say, 8s., leaving a profit of, say, 4s. per ton, equal to £10,200. The 25,000 payable tons at 6 dwt. would have under the same conditions a recovery value of 20s., which at the same cost of 8s. would leave a profit of 12s. per ton, or a possible profit of £15,000. By the provision of waste compartments in the underground bins—the cost of which figures out at about £50 on each bin—it would on the above showing enable the company to make an additional profit on the development rock of nearly £4,800. During the milling stage, with the same conditions as I have assumed, i.e., if the waste and unpayable ore from the development faces is kept separate from the payable ore and sent direct to the dump, and it is assumed that the yearly tonnage developed is equal to that milled, an additional profit of roughly £2,400 a year will be shown, and 13,000 additional tons of ore from the stopes can be put through the

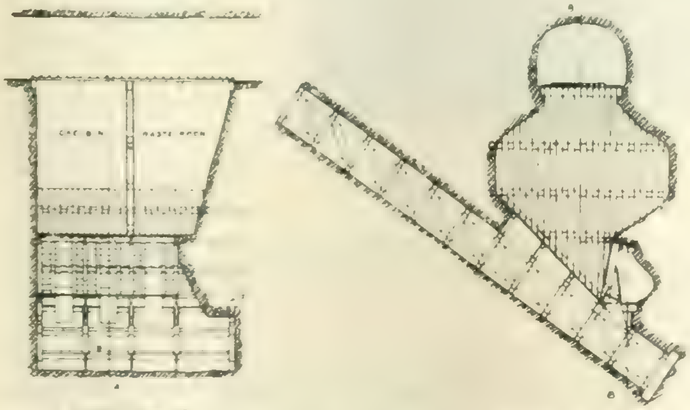


FIG. 4. SECTIONS OF UNDERGROUND BINS.

mill, each of which should show a profit to the company as against a loss if the waste had to be put through. I have not considered in the above calculations the possibility of discarding a large proportion of this waste on the sorting table, should no provision be made underground as I have indicated. The benefit that would accrue to the discarding of this waste on the sorting table will be more than balanced by the increased difficulty of sorting the waste contained in the ore from the stopes by the presence of the waste rock from development being mixed with it.

(C) *Grizzleys.*—The gauge to which the grizzleys are set is an important point, and one which considerably affects 'the speed at which the skips can be filled, and also the life of the chutes and discharge doors. I have found that a setting to admit only 6-in. cubes passing through into the ore bins is the best. With ample grizzley area for the bins, which would be obtained in the size of the bins I have indicated above, very little trouble is experienced by choking. The grizzleys should be made stiff enough to stand large pieces of ore being broken up on them ; 30-lb. rails I have found none too heavy. The suggestion made some time ago by Mr. G. A. Denny in his paper on "Underground Belt Conveying," to put rock breakers on the underground stations over the ore bins, is one which posesses a great attraction for me, as with such an arrangement grizzleys could be done away with in the headgear, and a large number of boys who are continually employed in breaking up the rock on the stations would be employed to better advantage elsewhere in the mine.

(D) *Discharge Chutes and Doors.*—The angle at which the chutes in an ore bin are set, and the ease at which doors can be operated, affect very largely the hoisting capacity of an engine. I have tried various designs, and find the ones indicated in figs 3 and 4 much the best. In this arrangement, the chutes are set at an angle of 45 deg. and look down the shaft. The skip man who is operating the doors is clear of the shaft, and is free from the danger which always attends when the doors are so arranged as to be operated from the shaft itself.

(E) *Type and Cost.*—In figs. 3 and 4 I have indicated two types of ore bins. In fig. No. 3, the whole of the rock is cut out of the hanging wall of the shaft, and the station and ore bin put in entirely with timber. In fig. 4, the station is cut independently of the bin, and the ore bin is of the type known as a rock box. These bins are of about the same capacity, and are designed for a four-compartment shaft only. The objections to the bin in fig. 3 are (1) that being carried entirely on the shaft timbers, the whole bin is apt to be knocked out should the skip come off the rails and catch the timbers ; (2) that should the timbers be weakened by rot, there is a danger of the box collapsing into the shaft. With regard to the first objection, the possibility of the skip coming off the rails, if the tracks are laid down and the chutes arranged from the ore bins, as I have indicated, is a very remote one, and need hardly be taken into consideration. As regards the second objection, if the main hauling way is arranged so that it shall be a downcast shaft and the timbers are creosoted or thoroughly saturated with a wood-preserving solution, a life of ten years, which is the basis we have assumed for the life of the mine, is not too much to expect for the box. The cost of No. 3 box is considerably less than No. 4, being for the sizes indicated in the sketches at least £300 cheaper to put in and can be completed in a much shorter time.

Read before the South African Association of Engineers.

In connection with the centenary of the birth of Benjamin Franklin, Mr. Marconi is to render a tribute to the memory of the great scientist in a lecture to the New York Electrical Society on the 16th prox.

OUR WEEKLY BIOGRAPHY.

PERCY GRIFFITH, M.Inst.C.E., M.I.Mech.E., F.G.S., Past-President of the Society of Engineers.

A[illegible] the present day can claim greater experience than Mr. Percy Griffith, who was born at Brentford in 1865. His preliminary education was obtained privately in London and Bexley, while his technical training was secured at the Crystal Palace School of Practical Engineering and at King's College. In 1883 he signed articles with Messrs. H. Young [illegible] with whom he remained for three years. Shortly after the expiration of his pupilage, Mr. Griffith was responsible, under Messrs. Young and Co., for the construction of an extension of the Godalming Waterworks. In 1888 he became assistant to the late Mr. Jabez Church, consulting engineer, and, after four years, a partnership was established between [illegible] which [illegible] the principal in [illegible], since which date Mr. Griffith has continued the practice.

[illegible]

PERCY GRIFFITH, M.INST.C.E., M.I.MECH.E., F.G.S.

During the years he acted as assistant he was engaged in preparing plans and specifications for gas and waterworks at Ilford, Clacton, Cromer, Braintree, Halstead, Balcombe, Goring, and Gainsborough, and during his partnership he practised as consulting engineer for these and other works.

Between 1890 and 1905 Mr. Griffith acted as consulting engineer to the Hornsea Urban District Council, Llandrindod-Wells Urban District Council, Wirksworth Urban District Council, Blaenavon Urban District Council, and to the Earl of Scarborough (Skegness water supply).

In 1904 [illegible] the new [illegible] works at Gainsborough, comprising a boring in new red sandstone, 1,500 ft. deep and 15½ in. diameter at bottom; this being the largest waterworks boring in the world, and the supply provided 35,000 gallons per hour. At present, Mr. Griffith is carrying out a deep well at Boultham for the Corporation of Lincoln, which [illegible] tap the same source of supply. This is here expected to be about 1,500 ft. below the surface. The shaft is 12 ft. diameter for a depth of 400 ft. and 9 ft. diameter to present depth (1,300 ft.). In view of the unsatisfactory character of present water supply, which is derived from the River

Witham and other surface sources, the new supply is looked forward to with considerable anticipation, both in the city itself and elsewhere. For the Selby Urban District Council he is now carrying out new waterworks, for which Parliamentary powers were obtained last year and he is also acting as consulting engineer to the Broadstairs Urban District Council, the Cromer Gas Company, the Skegness Water Company, the Chelmsford Corporation (water supply), and the Braintree Urban District Council (water supply).

As secretary of the British Association of Waterworks Engineers, Mr. Griffith edits the "Transactions" of that body, and thereby has records of recent waterworks' practice constantly before him He is the assistant secretary of the Joint Committee on Water Regulations, the author of a book entitled "Waterworks Law," and his literary contributions to the various technical societies of which he is a member include papers on the treatment and utilisation of exhaust steam and the water supply of small towns, the Halstead waterworks extensions, and the use of compressed air for raising water.

Mr. Griffith is secretary of the Braintree and Bocking Gas Company, and in addition to the societies indicated above, he is a member of the Institution of Gas Engineers and a member of the Southern District Association of Gas Managers.

NEW ELECTRICAL MACHINERY.

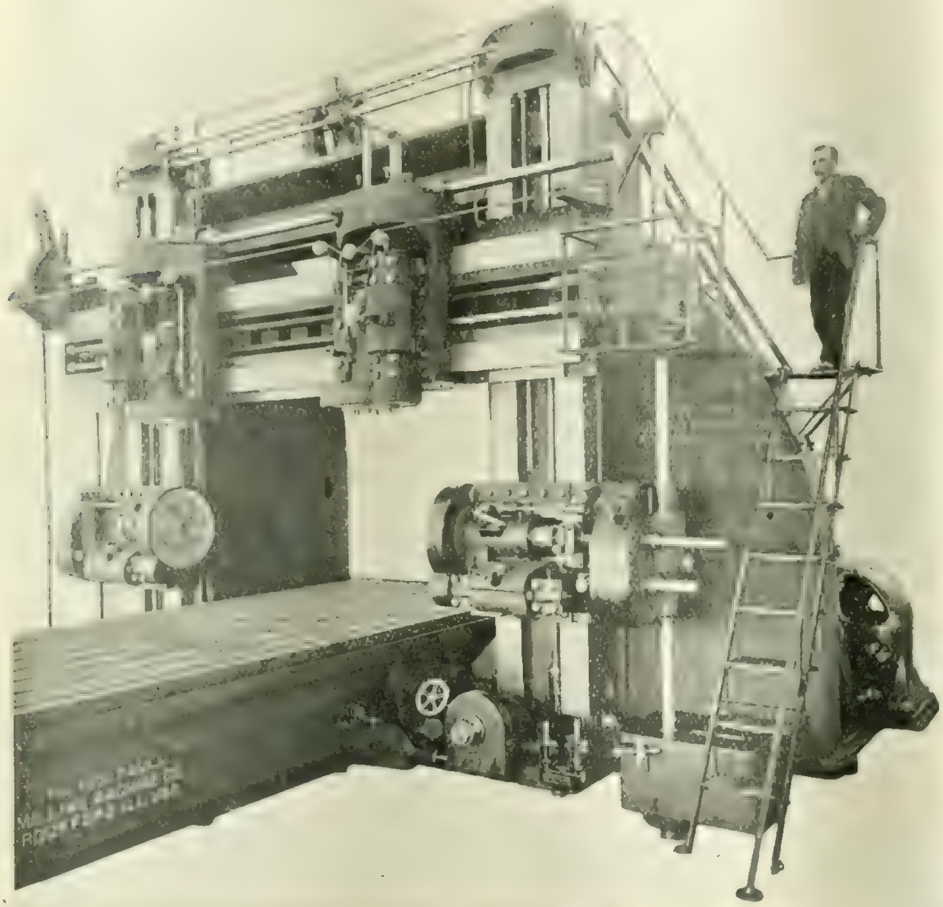
During the past year the Messrs. Ernest Scott and Mountain, Ltd., have completed some very large contracts, including, among others, the following: electric generating machinery for Messrs. Bell Bros., Ltd., iron and steel works, Port Clarence, consisting of a 450-kilowatts (600 electrical horse-power) continuous current dynamo, mounted on the crankshaft of a horizontal slow-speed steam engine. A similar set with coupled compound engine of Messrs. Robey and Co.'s make, was also supplied for the same station.

For the Consett Iron Company, co. Durham, the firm have completed what is believed to be the largest pumping installation in the country. This plant consists of two Scott and Mountain 500-h.p. three crank compound enclosed engines and dynamos, which supply power and current for driving the pumps and also for electric lighting throughout the works. The pumping station is situated about 1,000 yards from the engine-house, and adjoins the two new reservoirs which have been constructed by the Consett Company. In the pump-house there are three of Scott and Mountain's exceptionally heavy three-throw ram pumps, having a capacity of 1,500 to 2,000 gallons of water per minute, while working against a head of 300 ft. Some idea of the size of these pumps may be gained when it is stated that each pump will lift very nearly sufficient water per day for a population of 100,000 people on the ordinary town allowance of 30 gallons per day per head. The whole of the installation, including the engines, dynamos, pumps and motors, was made by the firm in their new works.

Messrs. Scott and Mountain have also supplied to Messrs. Cammell, Laird and Co., of Sheffield, one of their high-speed enclosed compound engines direct-coupled to one of their dynamos of 450 kilowatts capacity, and also another generator of similar size for mounting on the crankshaft of a compound slow-speed horizontal engine. At the present time they are completing an important contract for the Alquife Mines and Railways Company, of Spain. These mines are the property of the Coltness Iron Company, of Glasgow, and the Millom and Askam Company, of Cumberland, and the whole plant will be driven by electric current generated by water power in the district.

Other important work now in hand includes a large colliery installation for the Wigan Coal and Iron Company for their Manton colliery, this plant consisting of two three-phase generators directly mounted on the crankshafts of slow-speed engines, each having a capacity of 500 kilowatts (650 h.p.). This installation includes pumps, haulage gears, and other auxiliary machinery in the colliery.

For the Kent Collieries, Ltd., the firm have just secured a contract for an electric pumping installation to deal with an accumulation of water in the shafts which has for some time interfered with the progress of this company. The whole of the machinery will be be manufactured at the new Gateshead works, where a number of other important coatracts are in hand.



HEAVY FOUR-SPINDLE MILLING MACHINE TAKING A CASTING 10 FT. HIGH AND 10 FT. WIDE, BY THE INGERSOLL MILLING MACHINE COMPANY.

A RECORD MILLING MACHINE.

THE above illustration shows a 10 ft. four-head milling machine built by the Ingersoll Milling Machine Company, of Rockford, Ill., for the General Electric Company, Schenectady, N.Y.

The shipping weight of this machine was 315,000 lb. and it is claimed to be the largest milling machine as yet built. It is driven by four motors with a total of 120 h.p. A 50-h.p. motor drives the two horizontal heads, a 50-h.p. motor the two vertical heads, a 15-h.p. motor the table feed and power adjustment of the table and a 5-h.p. motor is employed for elevating and lowering the cross-rail. Each one of the four heads is capable of driving a 30-in. face mill, and each of the vertical spindles has reversible feed across the machine in either direction as well as power adjustment. The right hand horizontal head has a vertical up and down feed.

BOILER-HOUSE ECONOMY.

By Alfred W. Benn[illegible] M[illegible].E. A.I.E.E.

S[illegible] the [illegible] house.

[illegible] that, although coal may be cheap, boilers cost money [illegible] I have [illegible] thoroughly into this question," he said, "and I fi[illegible] repairs, [illegible] amount to at least [illegible] quently, even if the coal cost nothing, a ton saved per day would mean a saving of at least £40 per annum. In large collieries from 50 to 80 tons a day are burnt under the boilers, and in many cases it is practically certain that this consumption could be reduced by one-half.

WHERE BOILER-HOUSE LOSSES MAY OCCUR.

To enumerate some of the points that require careful attention and where unnoticed losses may creep in:—

1. Badly-designed flues or chimney causing bad draught. In cases of this kind we have known the [illegible] per cent. of the coal [illegible] bad draught.

2. Leaky brickwork in flues or chimney.

3. Paying too much for coal, though not knowing its calorific value.

[illegible] efficient heat transmission.

5. Using a high-pressure boiler for low-pressure [illegible]

6. Avoidable radiation losses through more boilers being in service than necessary.

7. Inefficiency, or lack of boiler, steam, and feed-water pipe covering. A reasonable return can be made even if it costs 1s. per square foot for covering. Experiments we have made show that each square foot of steam or boiler uncovered surface, wastes on an [illegible] coal per annum.

8. The excess of air necessary in low-temperature firing to keep down smoke.

9. Reducing the air supply too much through misinterpretation of the data furnished by gas analysis apparatus.

[illegible] economisers.

[illegible] combustion in hand and other inefficient furnaces.

12. Scaly and dirty boilers, economisers, etc.

13. No spare boiler, no time to clean, etc.

[illegible] Leaky steam traps. Arrangements should be made so that the outlet is always visible, when leakage can at once be rectified.

[illegible] Wasteful pump and auxiliary plant.

[illegible]

SOME REMEDIES FOR INEFFICIENT PLANT

Let us consider the chimney end first, as if this is wrong everything else will be so too. For every boiler of the Lancashire type of from 8 to 9 ft. diameter we want an area of 6 square feet in the chimney up to four boilers; after that we want 5 square feet for every additional boiler; the height of the chimney not to be less than 120 ft., and, unless there are special reasons for it, not more than 180 ft. But the entrance to this chimney must also be considered. Our draught has to turn up in the chimney, and therefore there is an obstruction here for which we have to provide by enlarging the entrance so that if the chimney itself has, say, four boilers 24 square feet, and two more boilers 10 square feet extra—making a total area of 34 square feet for six 8-ft. boilers—we want the chimney entrance to be at least 40 square feet; that is, roughly, 10 per cent. more.

FAULTY CONSTRUCTION OF CHIMNEYS

Now, if you have the chimney with a straight entrance into it, you will easily see that a portion of the chimney is lost, as the draught, having a considerable velocity, will push the air out and go a foot or so from the entrance before it turns up; therefore, we make the last foot or two of the entrance to the chimney at an angle of 45 deg. upwards. It is not necessary to make this round, as it will give a better result to have it at the angle stated.

We have now provided for a chimney and entrance—a chimney that will give us the highest result possible. It is safe to say that 90 per cent. of the chimneys erected are wrongly constructed in this particular.

MAIN FLUE

The next point to tackle is the flue to the econo[illegible], the economiser being the part of the flue system in work, continuously except for cleaning repairs, or some such reason, so we take the greatest [illegible] but not as large as the entrance to the chimney, and [illegible]

AREA OF ECONOMISER CHAMBER

[illegible] take into account the area between the pipes. Our flue, having an area of 34 square feet, we want at least 40 ft. in the economiser. This will probably be attained quite easily, as, if we have eight pipes wide and 3 in. between each of these pipes, there will be 20 square feet here, and, by keeping the side doors of the economiser open, we shall gain the other 20 ft. This is not as desirable a plan as can be devised, but it is much better than cramping the draught in the vain attempt to squeeze it through the tubes. Of course, if we can make the economiser wider and get it through the pipes, so much the better, but, if the draught is cramped and partially spoiled in the existing economisers, the results of firing are worse than they [illegible]

ECONOMISER WALLS.

Although it might be supposed to be outside the scope of this paper, a few words upon the building of the brick wall of the economiser which faces the open air may be of use: that is, the wall usually farthest away from the main flue. This is generally built as if it was the wall of a house, but it has an entirely different purpose to serve. It ought to be 14 in. thick, but, whether 1 in. or 9 in., it should be bonded at every row, and the bricks should be covered all over with mortar, not dabbed on as in ordinary building, and as is usual in building an economiser. It is a bricklayer's fallacy to suppose that cracks result from covering the bricks all over with mortar; if the covering be properly done on all sides of the bricks a much more lasting flue is built, and you do not find, at the end of a year or two, if you put a lamp flame near the economiser, that it is drawing at every pore. Flues built on this principle by ourselves did not require repairing after ten years, and there were no leaks, but in this case we took care that there was not too much mortar; that is, that the bricklayer did not leave ¾ in. or so of mortar between each layer of brick, which may be the easiest way of building, but not the best way for permanency. The 5 per cent extra cost of building in this way has fifty times over been paid for by the fact that subsequent attention to this part of the work has been unnecessary, no repairs being called for during a very long period.

MAIN FLUE FROM BOILER TO ECONOMISER

[illegible] into the economiser, the usual plan is to make a straight flue which ends in the economiser, and, however many boilers there are, not to enlarge it at all. [illegible] proper system is, at the end away from the economiser to make the flue at least one to two feet lower in the roof than at the end next the economiser, so that as the gases are increased in volume as they pass boiler after boiler they will roll with increased velocity towards the economiser. We shall at once be met by the objection that if it is requisite to have to pass the other way to the chimney when the economiser is stopped, this design cannot give as good a result as if the flue were full size. As a matter of fact, supposing the flue for our six boilers is 36 square feet, as it ought to be. If it begins at 6 ft. at the farthest end from the economiser and ends at 7 ft. 2 in., the draught will be as nearly as possible the same whether taken through the economiser or taken direct to the chimney without the frictional resistance offered to the flue gases by the economiser. Of course, when working without the economiser this will not be quite so good, as the work of the economiser is lost and the draught is no better. [illegible] year for the purpose of securing equal results during the thirteen that the economiser may be stopped. These points are frequently overlooked, but they are essentials in getting the best and most economical results.

THE BOILER

[illegible] this reason: Gases rise to the top and thus adhere to the boiler when they are moving horizontally underneath, but when they get into the side flues they do not adhere in the same way to the boiler, and the heat [illegible] well; this, I think, is self-evident.

The sum of the area of the two side flues of the [illegible] per cent. more than the flue total behind the boilers, but this is a minimum—about double that allowed for each boiler in the main flue. The reason of this is partly because of the enormous friction, and because the hot gases in active movement having to force their way into the main flue, require more room.

ECONOMY IN THE BOILER-HOUSE.

[illegible] use proper, [illegible] appliances for economising the cost of consuming the coal and preventing smoke. I recommend frequent sampling of the fuel used. It may be laid down in this connection that the sample and test should be [illegible] expert. What is done with which [illegible] to the interest of both buyer and seller may also be accomplished in the case of fuel, but the fuel tests must be intelligently conducted and controlled.

Fuel calorimetry is simple enough, and, though I would not advocate the placing of large contracts for fuel except from the results obtained by experts, I would have a calorimeter in every boiler-house equipment, and a small sample could be collected each day, averaged at the week-end, tested and logged up on the weekly coal and water record. It would soon be seen whether heat unit value for money was being obtained, and, should a doubt arise, a sample checked by a qualified coal analyst would turn doubt into certainty.

The fact should not be lost sight of that the furnace must be constructed to suit the fuel if high efficiencies are to result. We hold no brief, when considering boiler-house economy, either for shell or water-tube boilers. Each has its special advantages, and it is for those responsible for the conduct of the particular boiler-house to decide on the type most suitable in an individual instance.

IMPORTANCE OF HIGH TEMPERATURE COMBUSTION.

There are abundant facts to prove that it is more economical to work boilers at their full capacity and to have as few boilers at work as possible. Not only are radiation losses thus minimised, but the heat absorbing powers of the remaining boilers are improved.

It may be said that incomplete combustion, radiation, and loss of heat in the chimney are responsible for about 38 per cent. of the theoretical heat value in a boiler working alone, as the results of all experiments recorded by Mr. Bryan Donkin some years ago attest.

These experiments are, however, now quite obsolete, seven years being ancient history in this connection, for, working in connection with an economiser, [illegible] mechanical stoker and a superheater, as much as 85 per cent. can be utilised. Where economy is desired it is essential that careful firing should be carried out, and the efficiency of the furnace is therefore of the utmost importance.

The actual quantity of air required varies with different fuels, but, taken broadly, it may be accepted that complete combustion is interfered with by lack of air, while an excess of air causes waste of heat.

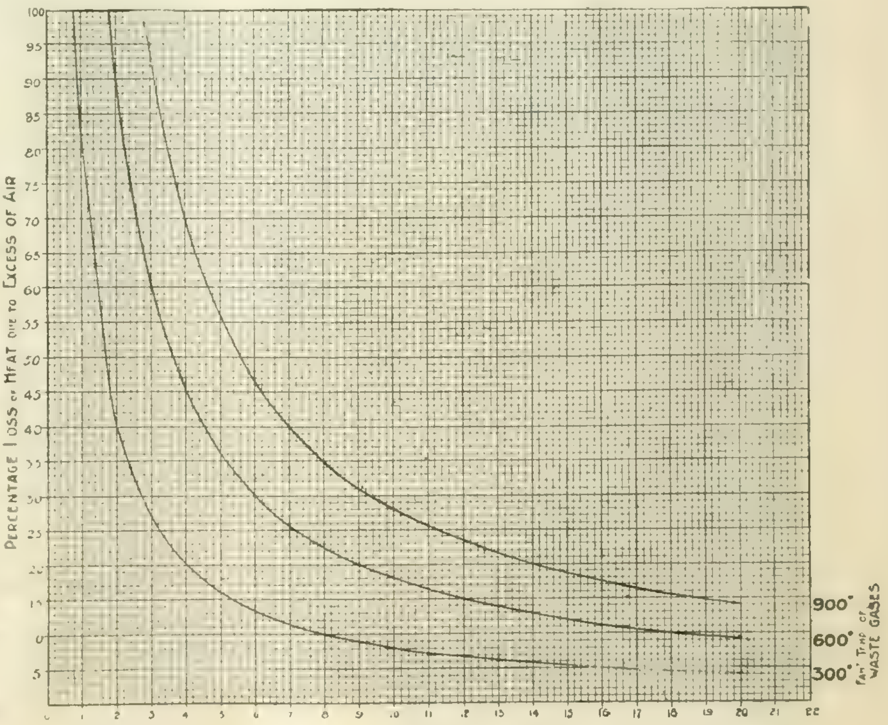
ANALYSIS OF WASTE GASES.

We do not now propose to give any account of the chemistry attached to the combustion of coal further than to allude to the analysis of the waste gases. This we consider an essential means of checking the actual efficiency which is being produced in the boiler, as it is by the composition of these gases and their temperature that we are able to tell whether the coal is being burned to its best advantage in any particular furnace.

The waste gases should be analysed frequently by some simple apparatus, such as the Orsat, and at odd times, so that the men never know when their firing will be checked.

THE PERCENTAGE LOSS THROUGH EXCESS OF AIR DEPENDS ON TEMPERATURE.

Needless to say no CO should be tolerated, since 1 lb. of carbon burnt to CO only gives 30 per cent. of the heat it will give if properly burnt to CO_2. The loss through excess of air is not constant, but depends on the temperature at which the waste gases escape to the chimney.



PERCENTAGE CO_2 IN WASTE GASES.

POSSIBLE ECONOMIES.

At 300 deg. [illegible] which is a reasonable temperature for the gases to go up the stack, the percentage of loss varies little between 12½ per cent. and 15 per cent. CO_2, only about 1 per cent. Now, unless the draught is keen, and the coal consumption per square foot of grate high, and the furnace temperature high in consequence, 15 per cent. CO_2 is a danger point, and CO should always be looked for, and, if it is found, my advice is let a little more air in, either by raising dampers, thinning the fire slightly, or forcing more air in through the bars of such a furnace as the compressed air furnace.

It is safer, in my opinion, to risk a slight excess of air than any CO, as with the latter you will always have a drop in temperature and almost certainly smoke.

At 600 deg. terminal temperature it will be seen the losses are much greater, and it is necessary to work nearer the danger line of CO to get even reasonable efficiency.

A good plan is to gradually collect over the whole day samples of the flue gases, subsequently subjecting them to analysis. The same observation applies to the ash, samples of which should be collected at the ash pit, ground and analysed. In this way it is easily possible to determine whether the coal is being efficiently burned or whether it falls below the standard required. An immense saving can thus be effected, provided that a systematic collection and analysis is ensured, merely unreliable and worthless results being obtained if a slip-shod manner of conducting the tests is countenanced.

DR. BOURNE'S SUMMARY.

Dr. Bourne, in his famous work, "Steam, Air, and Gas Engines," says, when summarising a number of experiments made in this country:—

1. "A moderately thick and hot fire with rapid draught uniformly gave the best results."

2. "In all experiments the highest result was always obtained when all the air was introduced through the fire-bars."

3. Difference in mode of firing only would produce a difference of 13 per cent." (in economy).

4. "Different fuels require different furnaces, and no one furnace of grate bar is equally good for all fuels."

METHODS OF FIRING.

Now, if [illegible] Lancashire boiler 12 cwt. of coal per hour be used, it is obvious that half a cwt. of this should be put on each flue every five minutes. If, as in hand-firing, three times this amount be put on every fifteen minutes, a very irregular production of steam is the result, and probably a very irregular production of smoke, because 1½ cwt. of coal is put [illegible] the amount of air [illegible] through the bars each minute, or, rather, I should say, somewhat less than it had before it received this charge of coal. One would never dream of putting steam into an engine in this way, or anything approaching it. At every stroke the same quantity of steam is applied except so far as regulated by an exact governor. There is here a proper mode of firing taught at once; thus one should be able to put a constant amount of coal on the fire per minute with a constant air supply, which is impossible by hand-firing. We must therefore choose which system of machine firing will be most economical and effective.

There are a number of machine-firing apparatus on the market that we all know, with varying capacities and efficiencies.

In one of these systems the coal is pushed over a plate on to the grate and carried along by the bars, or the fuel is fed on to a chain-grate, and the coal moves forward with the chain. The chief difference between these two systems is that in the former the bars move beneath the fuel, and if it is small they tend to riddle it through the air spaces.

THE CHAIN-GRATE STOKER.

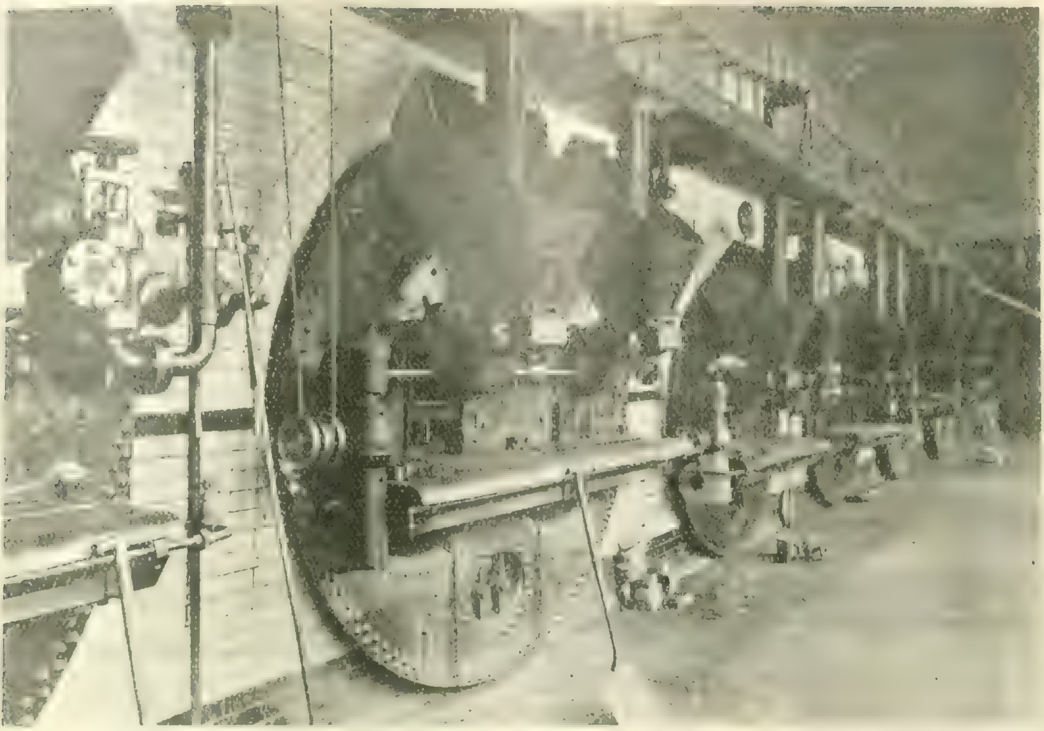
In the chain grate, on the other hand, there is no movement of the fuel relatively to the links, so that in the latest form of chain grate stokers with fine, well-distributed air spaces this riddling action is avoided.

Where the necessary evaporation can be done on this system it is a very good one for water-tube boilers, and is absolutely smokeless if not forced. It should be remembered, however, that larger grate area is required for the same duty than on a sprinkling stoker, and in some cases this may be a disadvantage. The only other system worth considering is the spreading of the fuel over the surface of the fire.

Some machines on this system have natural draught and spread the fuel over the whole grate at regular intervals in small quantities at a time, and thereby get an excellent result, except only that they have no command over the draught, and therefore are most suitable for regular loads; and where the draught is bad they are not able to get a reasonable duty or efficiency out of the boiler; therefore, it seems that the only system left, if we are to obtain the highest possible result, is one in which the air is forced in through the bars.

HIGHEST EFFICIENCIES AND DUTY OBTAINABLE WITH SPRINKLING STOKERS AND CONTROLLABLE FORCED DRAUGHT.

If the air be forced in underneath the furnace indiscriminately, it is liable to go to the one clean spot in the fire and thus produce blow-pipe action, which is detrimental to the boiler, but when the air is forced in through the bars themselves it is compelled to spread itself [illegible] section isolated by each



BOILER HOUSE WITH BENNIS STOKERS AND COAL-HANDLING PLANT. MESSRS. MARTIN, SONS AND CO., LTD., HUDDERSFIELD

particular bar, and as near perfection is attained as is perhaps possible at the present time. In point of fact the existence of this blow-pipe action in most of the high-temperature furnaces hitherto constructed has been the reason why eminent authorities have expressed the opinion that these high temperatures are detrimental to the boiler. As a matter of fact, it is not the temperature itself but the existence of great variation in temperatures adjacent to one another in the furnace which does the damage. Boilers like those at the Sheffield Lighting Station have actually been evaporating 11 to 14 lb. of water per square foot of boiler-heating surface per hour for 3½ years, and all the leakage due to the intermittent temperature of hand-firing have been cured by these high-temperature mechanical stokers, with compressed air furnaces.

The coal being spread over the fire at very short intervals, say, about one-twelfth of a minute, is consumed almost as soon as it falls on the bars, giving up its calorific value in the most effective manner [illegible] high temperature.

COAL HANDLING.

[illegible] the subject of machine stoking [illegible] turn to that of the next possible economy—coal and ash-handling plant.

A first-class conveyor should possess flexibility of application so that it can be adapted to awkward and complex cases and yet show a large yearly saving on capital outlay. It should be successfully operated with a minimum of power, while it should certainly be driven by a simple and reliable device. The cost of handling of each conveyor, including interest on capital expenditure, attendance, oil, motive power, depreciation and repairs, should work out at a fraction of a penny per ton. The general construction of the conveyer should admit of the interchangeability of its parts, and it should be possible to diminish or increase its capacity to suit circumstances. It is essential that a good conveyor should be capable of elevating the materials to any required height, that it should be adapted to carry all kinds of material, that its distinctive features should be cheapness in application, simplicity in working, and durability in practice, while it should be quite possible to take the driving power from any convenient means at hand, and the driving power taken per ton of material carried should be small.

CONCRETE EXAMPLES OF THE EMPLOYMENT OF ELEVATING AND CONVEYING MACHINERY.

As concrete examples of what can be done by the intelligent use of carefully-designed elevating and conveying plant in the matter of boiler-house economies, attention may be called to the automatic machinery [illegible] installed at Coventry Corporation Electric Power Station; the County of London Electric Supply Company's Station; the City of London Electric Supply Company's "Bankside" Station; the Bristol Corporation [illegible] Martin, Son and Co., Ltd., at Huddersfield.

I [illegible] most "up-to-date" plants in the country. I believe I am correct in stating that they were the first to [illegible] their fuel in. Tramway lines have been run from the main road right into the works. A special form of side door electric tramway truck was built by Messrs. G. C. Milnes, Voss and Co., with Westinghouse controllers for the purpose.

This electric railway truck brings the coal in and deposits it, as depicted, over a coal hopper. The hopper is formed of cast-iron plates supported on joists, which are let into the brick walls for forming the hopper pit. A "Bennis" Steel Chain Conveyor runs through this coal hopper, taking up the fuel at [illegible] and then running [illegible] hopper.

This combined elevator and horizontal conveyor [illegible] channel-shaped trough made out of close hard-grained cast-iron ⅝ in. in thickness, strongly ribbed, 9 in. in width and [illegible] in. in depth. The conveyer chain con[illegible] open-hearth acid mild steel flats. The links are 12 in. in pitch, and secured at joints by means of specially constructed rivets and washers.

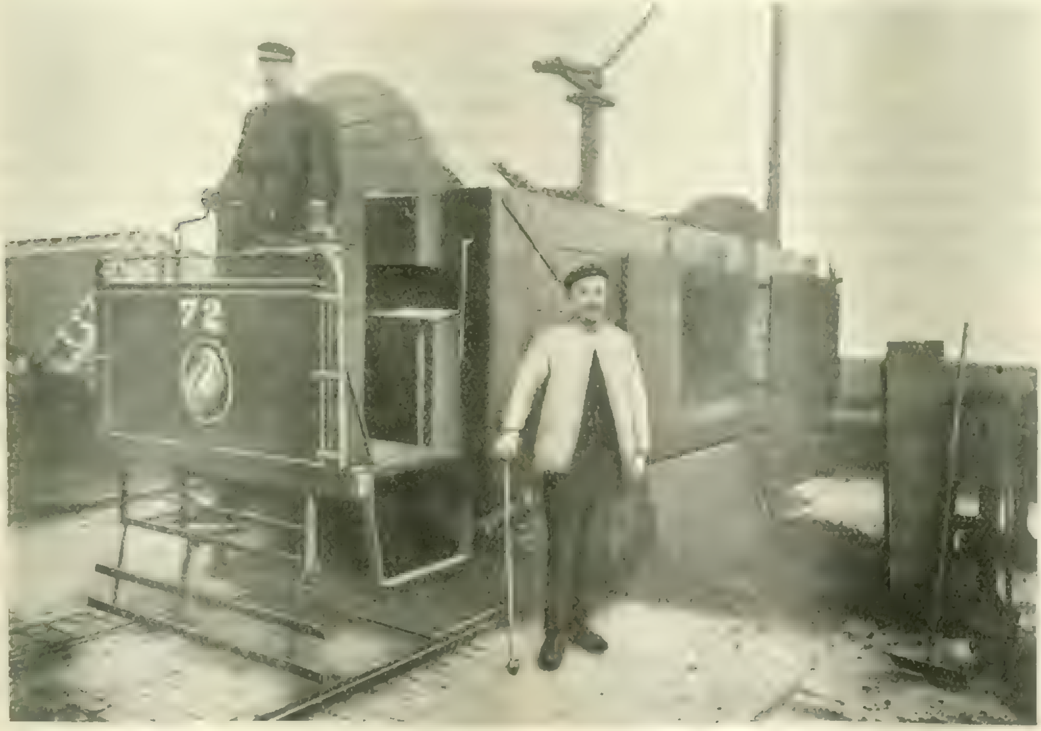
The coal is distributed through the shoots into the mechanical stoker hoppers. The stokers are of the "Bennis" make, with self-cleaning compressed air furnaces.

Each of the distributing shoots is fitted with cut-off slides, so that the supply can be stopped in the event of any boiler being taken out of service.

The conveyor chain is driven by means of a horizontal drum with drags in two spur-wheel reductions.

The whole of the plant, including the stokers, is driven by a slow speed engine, 8 in. cylinder by 9 in. stroke. The saving made by the stokers and conveyors has been very considerable, and such ito fully justify the outlay on the plant.

[illegible] Engineering Society, Huddersfield.



SPECIAL ELECTRIC TRUCK FOR CONVEYING [illegible]

ELECTRIC MAINS FOR POWER TRANSMISSION WORK.

By John T. Morris, M.I.E.E.

Extra high-tension power transmission is usually carried out with three-phase currents, which system includes nearly the whole of extra high voltage power transmission work. There are a few samples of direct current, a few of single-phase, and a fair number of two-phase transmissions.

Direct current transmission examples are shown in the following table:—

Direct Current Power Transmission Thury System.

		Max. Volt.	H.P.	Length of circuit Miles.
La Chaud de Fonds	..	14,000	3,600	32
St. Maurice-Lausanne	..	23,000	4,600	35
Moutiers-Lyons in course of construction ..	..	60,000	6,000	114

At the present time the three-phase system undoubtedly holds the premier position for long-distance power transmission, chiefly because the weight of copper required is smaller than in any other alternating system, when the same voltage is the determining factor. All alternating systems labour under the disadvantage of the possibility of increased losses in the line due to lagging or leading currents, also that any synchronous machinery is apt to be thrown out of step by a sudden short circuit.

OVERHEAD MAINS.

Practically only two materials are employed; hard drawn copper, and aluminium. American practice seems to show that up to 0·3 of an inch diameter, solid hard drawn copper wire is employed. Above 0·4 of an inch stranded copper wire is almost always used. With regard to intermediate sizes, practice varies. Aluminium wire is usually stranded for the work, and is stronger than copper for the same conductivity, but the wind-pressure is greater with aluminium, owing to the greater surface for a given conductivity.

Experiments conducted on a span 950 ft. in length, supported on poles 45 ft. high, give as a relation between velocity of wind and pressure on cable $P = 0{\cdot}0025\ V^2$ for a stranded cable, where P = pressure per square foot of projected cable area and V = actual velocity of wind in miles per hour. Apparently, sixty-five miles per hour may be taken as a reasonable maximum for wind velocity if such exceptional events as tornadoes are left out of account.

To quote an example of one of the longest existing spans, there is an aluminium line on the West Coast of America having a single span of 1,800 ft.—rather over a third of a mile.

It may be mentioned that steel is not very far from competing with copper and aluminium for long span work, particularly on account of its smaller co-efficient of expansion, and also its greater tenacity

POLE CONSTRUCTION.

Poles are either made in wood, or some kind of wrought iron or steel construction is adopted. It is practically essential for long spans to use the latter, on account of their greater strength and durability. There is, however, a drawback with regard to small steel towers, from the point of view of continuity of supply, which is, that should an insulator break and the wire fall, the line will have at once to be shut down, while with wood construction several minutes will probably elapse before a blaze is started which will short-circuit the line. Indeed, a case is known of a 40,000-volt three-phase-circuit, with grounded neutral, where the wire lay on a dry cross-arm for several hours before the circuit could be switched over, and even in this case the cross-arm was not badly charred. It may be of interest to note that an extremely rough rule for giving the distance between wires, is that the distance in inches is equal to one and a half times the number of kilo-volts used.

A reasonable loss in the line is about five per cent. of the energy transmitted per fifty miles, though a smaller loss than this may well be obtained.

The following are some of the main points requiring attention in the design of high tension insulators: There must be no flaws or cracks; the material should have a high dielectric strength; the surface leakage must be small, even when rain is falling, and the distance from the edge of the "umbrella" to the pin supporting the insulator must be sufficient to prevent arcs from starting; the mechanical strength also must be ample under working conditions.

DISTRIBUTION OF ELECTROSTATIC STRESS IN AND AROUND AN INSULATOR.

Take for example one of the insulators used in the Shawinigan-Montreal transmission line, which works at 53,000 volts three-phase; and consider as an extreme case 50,000 volts between the line wire and pole arm when rain is falling. The whole of the upper side of the "umbrella" will be at the same potential as the wire. If the potential gradient is too steep at the surfaces of the insulator, then a brush discharge will start from the edges, and this means that the surrounding air is rendered partially conducting, or is ionised, as it is called, which possibly will reduce the effective thickness of the dielectric, and this may cause a breakdown.

Expert opinion in the States seems to incline to the belief that the surface leakage effect is in reality extremely small. This is mainly due to the fact that at these extra high voltages surface leakage cannot permanently exist, since the conducting path will vanish, owing to the heat produced by the leakage current itself. As is well known, when conductors are connected in series, the voltage divides in the inverse ratio of their capacities.

BURNING OF PINS.

Pins are usually made either of locust, oak, or eucalyptus wood, carefully treated so as to exclude moisture. Iron pins are also largely used. After a line has been in operation for some months, the pins carrying the insulators, if of wood, are sometimes found to have a charred appearance. This is caused by a discharge, which can be seen at night, and which produces an appreciable sound. This charring effect is practically absent below voltages of 20,000, but at 40,000 becomes a factor requiring serious attention.

Iron pins are much better from a mechanical point of view, but the attachment of the insulator to them requires care.

UNDERGROUND MAINS.

For underground main work there are practically only two kinds of insulating materials which can be employed. These are rubber, and paper.

Formerly, the insulation resistance of a cable was regarded as the most important factor to be taken into account. Nowadays, however, it is almost left to take care of itself, and instead, attention is directed to breaking-down strength, and bending tests, and, after the cable is laid, to its withstanding about double the ordinary working pressure for a period of an hour.

DIELECTRIC STRENGTH AND SPECIFIC CAPACITY.

Signor [illegible] gives the following data for dielectric strength and specific capacities as good working averages for materials used in cable manufacture:

Dielectric strength of rubber in lengths on cable 12–15,000 volts per m.m.

Dielectric strength of paper in lengths on cable 8–10,000 volts per m.m.

Specific [illegible] of Various Materials.

Paper cables	3–4
Paper	about 2
Resin	2–3
Mixtures used for impregnating	3–4 [illegible]
Pure vulcanised rubber, about	3

The addition of certain materials to rubber raises its specific capacity without appreciably altering its dielectric strength.

Within the last three or four years the above design had been modified in the majority of extra high-tension three-phase cables in this country, which now have cores of a 120 deg. sector shape in place of the circular, the three corners being more or less rounded. This results in making the dielectric stress more uniform, owing to the fact that the dielectric is more uniform in thickness between the cores and also between each core and the sheath. In the recently introduced so-called "Laminæ" Henley cable, this idea is even more perfectly carried out.

CABLE CONSTRUCTION.

Lead sheathing is naturally fairly fusible and not of very great conductivity, and it is conceivable, though unlikely, that a severe short circuit might result in a portion of the lead sheathing assuming a considerable difference of potential with respect to the earth in which the cable is laid, which might cause more than unpleasant surprises to passers by. To minimise the risk, the Board of Trade has favoured the introduction of a number of thin copper strips placed directly beneath the lead sheath; the object being to increase the conductivity and diminish the fusibility of the sheathing as a whole. Occasionally, as in some of Callender's mains, the internal copper sheathing is replaced by external galvanised iron armouring, in direct contact with the lead sheathing.

It is interesting to note the various means employed by manufacturers to diminish the lost space due to the section not being quite filled with copper—as, for example, the "hammered" sections B.I. and H.C.; the introduction of a few wires in the strand of different diameters, as in Siemens, and the almost complete use of the space as in the Henley "Laminæ" cable.

Another cable of special interest from the point of view of insulation is one recently designed by Signor Jona, of Messrs. Pirelli, Milan. It is a single core cable, having, as previously mentioned, a thin lead sheath encasing the stranded conductor, and has graded insulation from the inside outwards. This has the effect of giving a more uniform distribution of potential gradient. There is first a layer of dielectric of specific capacity 6·1, then a layer of specific capacity 4·7, then one of specific capacity 4·2, and finally, a layer of specific capacity of 4·0, over which the ordinary lead sheath is placed. This particular cable has successfully withstood a pressure of 150,000 volts for one hour.

ENERGY LOSSES IN CABLES.

By far the greatest loss in cables is due to the resistance of the conductors. Other losses are unimportant when compared with the total power supplied by a transmission, as the transmission losses themselves are of the order of five per cent., while these minor losses are not greater than ten per cent. of this five per cent., which means only a half per cent. of the total.

The greatest care has to be exercised in the jointing of extra high-tension cables, as also in the connection of junction boxes and end connections, otherwise there is serious risk of the insulation failing at these places.

RESONANCE.

All lines possess a certain amount of capacity and inductance, and the circuit has a natural time of swing of its own—from an electrical point of view, that is, energy gets alternately stored in a state of strain in the dielectric, and in a magnetic field. Generally, this time of swing is much shorter than the period of the alternating current employed, and trouble does not arise. But though the fundamental of the wave may not resonate, it is not at all improbable that the third, fifth, or seventh or other odd harmonics might resonate, and cause a breakdown of the insulation through too great a rise of voltage. It is for this reason that simple sine waves of E.M.F. are to be preferred for power transmission.

SURGES.

A surge in an electric circuit is generally caused by the extremely sudden stopping of an electric current in that circuit, such as might be caused by the instantaneous interruption of a short circuit, for just before the interruption of the short circuit a large amount of energy is stored in the space surrounding the conductors in the form of a magnetic field. Immediately on interruption of the short circuit, as the current is stopped the energy can no longer remain [illegible] contained in a magnetic field [illegible] must be at once converted into electrostatic stress in the medium; that is, a great voltage will be suddenly produced between the conductors. The magnitude of this surge voltage, as it is called, is approximately independent of the length of the line, and it is proportional to the current broken and to the square root of the ratio of the inductance of the circuit to the capacity. Hence the surge voltage is greatest where the inductance is high and the capacity low, which means that the surge voltage for an overhead transmission will be much greater than for an underground cable. Prof. F. G. Baum has shown that the surge voltage for an average overhead transmission cannot be greater than 200 times the current in ampères, at the instant of breaking. Further, as a consequence if E = R.M.S. voltage between line wires and neutral and C = current the instant before interruption, then for a sine wave with instantaneous interruption the

Maximum strain in volts = $1{\cdot}4\,(E + 200\,C)$.

The surge voltage will be less than this by an amount dependent on the slowness of current interruption. He further points out that with still greater increase in the length of transmission lines, if some hundreds of miles are used, the surge voltage frequency may not be very far from the frequency of supply, which means that some factor in the circuit must be modified in order to avoid the possibility of the natural time of swing of the circuit coinciding with the working frequency. Needless to remark, this case can hardly occur in our country.

Actual experiments on a 100-mile line working at 40,000 volts have shown that, on suddenly removing a short-circuit, induced (or "kick-back") voltages are produced, varying from two and a half to six times the normal voltage; this pressure being measured by the length of air-gap broken down. Should a distributed load be used these effects will be greatly reduced.

LIGHTNING AND SHORT CIRCUITS.

A lightning arrester ought to be able to remove swiftly from the circuit any sudden abnormal rise of pressure, and should not short-circuit the line immediately afterwards. It is probable that the most reliable arrester would be one having a capacity in parallel with an inductance in order to be able to absorb high or low frequency effects, but so far no good arrangement of this sort has been devised. Up to a pressure of 25,000 volts or so, arresters of the non-arcing type, that is, with multiple gaps in series, used either with or without a resistance in series, appears to give reasonable security. Above this voltage a modified form of the Siemens' arrester has been [illegible] for [illegible] currents up to [illegible] volts, when used with a suitable resistance in series between it and the ground. This latter is most important, or dangerous surge voltages will result on the sudden breaking of the arc across the arrester.

It is now considered good practice to fix static dischargers at each end of a transmission circuit of any length [illegible] for overhead and underground circuits.

BOARD OF TRADE REGULATIONS.

The position of the Board of Trade with regard to extra high-tension transmissions at the present time would appear very reasonable. No hard and fast rules have as yet been made, each individual case being considered on its own merits.

It is understood that a definite set of regulations as to extra high-tension work is about to be issued by the Board of Trade, but it is not as yet published. It will, without doubt, be of the greatest interest.

Abstract of paper read before the [illegible] Institution of Engineers.

OPENINGS FOR TRADE ABROAD.

Germany.

It is reported that a number of additional electric tramways are to be constructed for the city and suburbs of Hamburg at an estimated cost of £2,000,000.

Spain.

Tenders, which will be received up to February 6th next, at the office of the Secretary to the Port Works Board, Vigo, are invited for the supply of a petrol motor launch to be used in the service of that Board.

On January 6th tenders will be opened at the "Casas Consistoriales," Puente Genil, for the public lighting of that town by means of electricity during the period of ten years ending December 31st, 1915, at the upset price of about £249 per annum. A supply of 2,500 candle-power will be required.

Bolivia.

Referring to the development of railway construction in Bolivia, the Chilian Times states that the surveys for a line from Oruro to Cochabamba are well advanced, and the Government has entered into a contract with the Antofagasta and Bolivia Railway Company for the survey of a line to unite Uyuni with Potosi. The survey and plans are to be completed not later than [illegible]

Mexico.

An opening for a hydro-electric plant occurs in the State of Vera Cruz, where Mr. J. B. Tannar has made an application for an appropriation for industrial purposes of 2[illegible] litres per second from the River Jamapa.

Brazil.

The M[illegible] Ways of Communication and Public Works has been authorised to expend about £1,250 on plans for the construction of a railway between [illegible] Province of Maranhao.

United States.

Portland and Kennewick are to be connected by railway, and a track about 200 miles long will be needed, as well as two bridges over the Columbia and Willamette rivers. It is proposed further to construct a railway between Bellingham and Spokane about 300 miles, dry docks in Bremerton, and a new transcontinental line to a point on Puget Sound.

Ceylon.

From a report of the opening of the Legislative Council, published in the Ceylon Government Gazette, it appears that the public works proposed for the forthcoming financial year, include, besides the construction of buildings, roads and bridges, a sum of Rs. 1,500,000 on railway construction. Of this, some Rs. 350,000 represents additional works of ordinary character, Rs. 75,000 to complete the tunnels on the Kadugannawa incline, Rs. 100,000 for works at Polgahawela station, Rs. 300,000 (Rs. 150,000 in the present and Rs. 150,000 next year) for six new locomotives, Rs. 400,000 for new trucks and rolling stock, and Rs. 350,000 for works at Colombo.

British India.

The East Indian Railway Company are prepared to receive tenders for the supply and delivery of deck bridges (about 60 ft. in the clear), as per specification, to be seen at the company's offices, Nicholas Lane London, E.C. Tenders are to be sent to the secretary not later than noon, January 3rd next.

Egypt.

Tenders, which will be opened on February 10th, 1906, are invited for the construction of two breakwaters and the supply of concrete blocks, in accordance with specifications on view at the office of the chief port engineer, Alexandria. Tenders, in double envelopes, the outer addressed to "M. le Directeur-Generale des Ports et Phares," Alexandria, and the inner inscribed "Offre pour la construction de deux brise-lames et pour la fourniture de blocs artificiels," should be delivered not later than noon on February 10th.

Belgium.

Tenders are invited for the supply of various manufactures [illegible] required for the use of the Belgian State Railways in 1906. The adjudication will take place at 1 p.m. on January 3rd at the Bourse, Brussels.

40-H.P. NAPIER CHASSIS.

MOTOR NOTES.

THE PARIS MOTOR SHOW.

THE exhibition at the Grand Palais and the Serres de la Reine has been the usual success. The plan of housing the industrial wagons, the motor omnibuses, and the autoboats and machinery separately is an excellent one, and the Grand Palais was thus left free for a magnificent display of touring cars.

Among the leading French types of car shown, the Mercedes naturally occupies a prominent place, and, as a matter of fact, many of the modern high-class touring cars are based on the Mercedes model. A few modifications have been made from last year's pattern, chief among which are the simplification of the ignition and the new carburetter, which is certainly original in design.

The Darracq car also embodies some novelties, principal among these being mechanical government of all valves. The four-cylinder machines are of 15, 20 and 40 h.p. For all three types the chassis is very strongly built. All the models have three speeds, and backward drive, the top speed being direct. A novel type of clutch has been introduced, permitting a progressive start. There is also a new system of automatic lubrication enabling all joints to be done away with. Some of the principal English car exhibits are noted in detail in the following pages.

A visit to the commercial vehicle section of the show brought pleasant reflections to British visitors. In the omnibus and lorry section it is plain enough now that British manufacturers have taken the lead. In Paris one sees little or nothing of the motor omnibus, and although French manufacturers are making omnibuses these are mainly to the order of the London companies, the demand, as is well-known, being now very much in excess of the supply possible within at least a reasonable period. Nor was the motor-boat section of a character to compare with the recent exhibit in this class at Olympia. In the machinery section some of the English exhibitors made an excellent show, notably Messrs. Ward, of Birmingham, and Messrs. Herbert, and Parkinson, of Coventry. Altogether the impression given by a visit to the show is that British manufacturers are regaining the ground lost in the pleasure car business, and that in the commercial branch of the trade they are destined to hold the lead. At the same time the French trade in cars with Great Britain is not diminishing, but this is accounted for not by any fresh lead assumed by France, but to the progressive state of the industry as a whole.

S. F. EDGE AND CO.'S SIX CYLINDER 60-H P. NAPIER CHASSIS.

The engine has the six cylinders arranged in pairs with the inlet and exhaust valves side by side on the left hand. The valves are direct-acting, driven from the cam shaft, which with all its actuating mechanism is enclosed in the crank chamber. A feature in the arrangement of the details of the engine is [illegible]. The [illegible] of the inlet and water circulating pipes is worthy of attention.

The Napier carburetter and hydraulic air regulator is fitted. A convenient little device is that enabling the carburetter to be flooded when required without raising the bonnet of the engine. It should be noted the car has the system of chainless drive, which system was originated by the Napier firm on cars of large horse-power. Apart from the mechanical advantages of the system itself every portion of it is cut from the solid steel.

Lubricating is self-acting, worked from a small force-pump driven from the engine, and every bearing is automatically and continuously lubricated. The ignition is the Napier synchronised, and it may be mentioned that the mechanism for advancing and retarding has been considerably simplified.

The clutch is self-lubricating, which ensures that whenever the clutch is taken out a thin film of oil immediately runs over the disengaged surfaces, so that when the clutch is let in again, this oil is gradually forced into the little reservoirs that are provided for it, this ensuring a certain amount of slip before the gripping action takes place. Three speeds and the usual reverse are provided. In the top gear the drive is direct to the road wheel-axle. The gear-axles run on ball bearings, and the whole is contained in a relatively small box.

Ball bearings are provided to the front road-wheels, and the live axle is fitted with roller bearings to take the weight and balls to take the thrust. Ball bearings are also fitted to the steering box, containing the screw and block. The long road springs and the way they are attached to the chassis frame attract attention.

On the shaft the differential universal joints are cased in, and, unlike the usual principle, radius rods are [illegible] in [illegible] instead of [illegible] [illegible].

DENNIS PATENT WORM GEAR

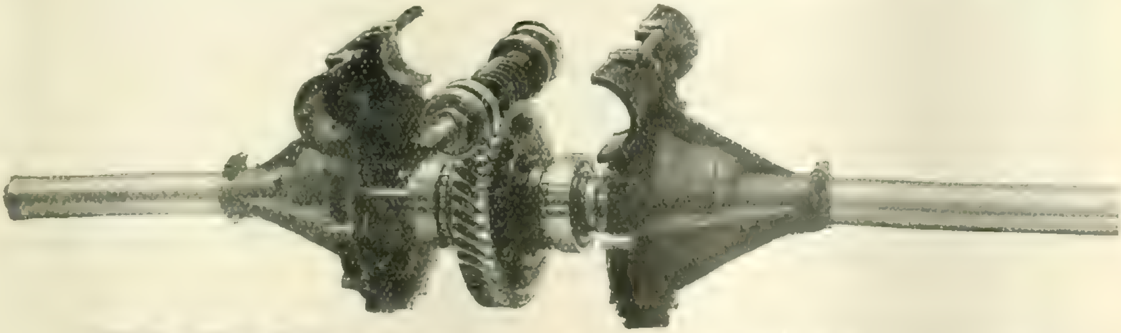
We illustrate to-day the patent worm gear which has been recently applied by Dennis Bros. to motor omnibuses—worm gearing which has stood the test of thousands of miles with entire satisfaction. It is a perfectly silent drive, and it is claimed that the efficiency is equally displayed whether the worm pinion is driving the worm-wheel or the worm-wheel is driving the pinion.

The worm-pinion is contained in a specially constructed differential gear-box, and runs on each end on most efficient large ball journal and thrust bearings. The worm-wheel, of 4-diametral pitch, encircles the differential gear, which is of the parallel pinion type with six pinions and two star pinions. The rear axle casing is a malleable casting, with specially strengthened outer flanges, into which are screwed and locked the live axle casings. These casings extend and take the bearing of the road wheels, which take up the drive through driving stars engaging with the square end of the live axle, and fitted into recesses on the rear hubs. It will be observed that by this system of drive the wheels have an independent bearing of 10 in. in length, on which to support the weight of the 'bus and passengers, and the live axle has to transmit the drive only.

All the pushing strain is taken by the horn-plates, and the vertical action of the springs is taken by phosphor-bronze slides, with oil-boxes cast in them.

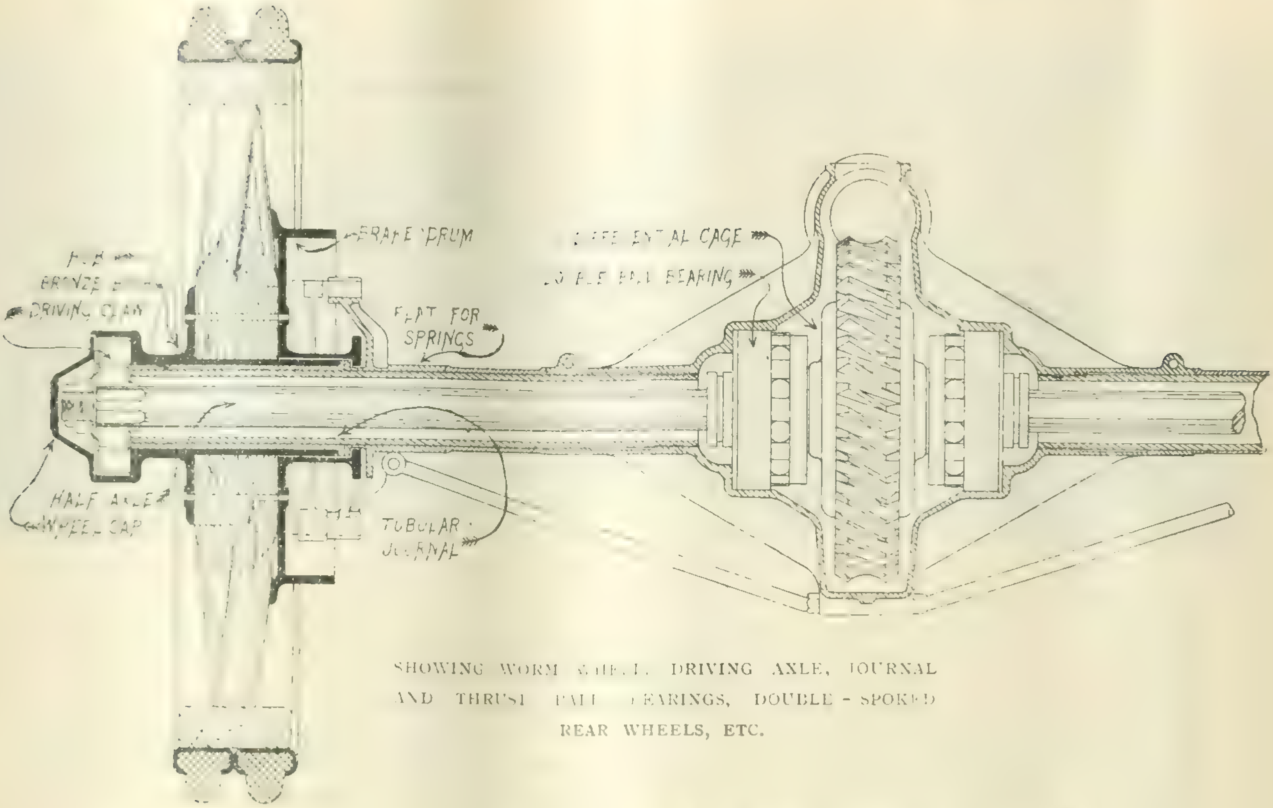
GEAR BOX.

The gear-wheels are made from case-hardened forged steel, of large diameter, with increased width of face admitting a 4-diametral pitch tooth. There



SHOWING DENNIS DRIVING AXLE AND WORM SUPPORTED ON LARGE DIAMETER COMBINED BALL JOURNAL AND THRUST BEARING.

The rear wheels have a 10-in. phosphor-bronze bearing on [illegible] casing, thereby relieving the driving axle of any weight, which engages through [illegible] clutch with the outside of the driving wheels.

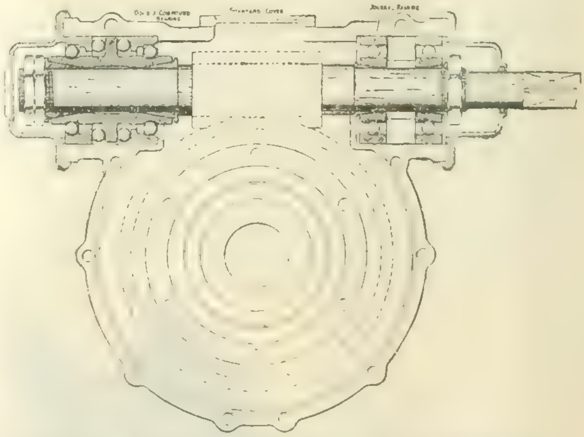


SHOWING WORM WHEEL, DRIVING AXLE, JOURNAL AND THRUST BALL BEARINGS, DOUBLE-SPOKED REAR WHEELS, ETC.

is sufficient lead on the sliding gears to facilitate changing, and a direct drive is obtained on the top speed, disengaging entirely the secondary shaft through [illegible]

When the lower half of the case is detached, it reveals the bolts and clips, keeping the main shaft in position, which can be lowered without disturbing the clutch or bolted section of the gear-box. It is said to be the only omnibus or heavy vehicle gear-box with a direct drive on the top speed, in which the secondary shaft is stationary and no gear-wheels revolve.

Attention may be directed to the large diameter journal and thrust ball bearings to the main shaft, and the detachable lower half of the box, taking away the secondary shaft and reverse gears without disturbing the main shaft, which in turn can be lowered without disturbing the main gear-box frame.



SHOWING WORM PINION SUPPORTED ON LARGE DIAMETER BALL JOURNAL AND THRUST BEARINGS.

ENGINE.

The motor of the 24-h.p. four-cylinder motor omnibus is of the enclosed vertical type, and has four cylinders, 4 in. bore by 5 in. stroke, developing 24 h.p. at 900 revolutions per minute, with the power to accelerate at 28 h.p. The 20 h.p. has a 4 in. bore by 5 in. stroke, developing a 20 h.p. at 900 revolutions per minute. The cylinders are cast separately, and the crank-shaft has a bearing between each cylinder. The crank-shaft is case-hardened, with ground-bearing surfaces. The ignition is high-tension electric, and the engine is fed from the Dennis automatic carburetter. The bottom half is detachable, without disturbing the crank-shaft, to admit of easy examination or adjustment of the bearings.

RADIAL TRUCK BY THE BRUSH ENGINEERING [illegible]

IMPROVEMENTS IN TRUCKS.

A PAPER [illegible] Mr. Elmer [illegible] of the Tramways and Light Railways [illegible] December [illegible] 8th. The author [illegible] quite obvious to everyone engaged in the operation, building or equipping of tramways, that more attention must be paid to what had heretofore been considered of minor importance, namely, the truck or bogie. With the exception of probably the radial truck, there had been practically no improvements worth mentioning in electric-traction trucks for the past six years. Nearly all the defects to be found in the present trucks might be summed up in the one phrase, "bad fitting." Such an important member of a car should never have been allowed to be put together in such an unworkmanlike manner. By well-designed, he meant that not only were the various members of the truck all logically of the correct proportions regarding strength, and consistently light throughout, but that the spring distribution, especially in the case of the rigid wheel-base single truck, had reached a degree of art which might be termed perfection. The tramway manager looked at the wreck [illegible] with [illegible]. He examined the various parts of its anatomy, he [illegible] the [illegible] lack of symmetry in the horn block openings, the journal brasses worn to a knife-edge at one end, while still retaining half its original metal at the other end; the journal brass worn entirely through on one side, while the other side was almost as perfect as the day it was cast; or the axle journals worn taper due to uneven wear, and he asked himself the reason.

FAULTS IN STANDARD TYPES.

In plain English, the only fault which could be found with the standard types of trucks to-day was [illegible] and the [illegible] in bolting together as in many of the other less important parts of the car. The causes which had contributed towards this discreditable state of affairs had, in Mr. Cook's opinion, been entirely due to the inexperience and conservatism prevailing throughout the tramway world, including the committees, as well as the engineers and managers. It was all a question of price. So conservative were the various committees and engineers that even a British-made truck could not be sold in competition with cheap American trucks, unless the price was less.

AVERAGE LIFE OF TRUCKS.

The average life of this type of truck was about five years, which was about the length of time that had elapsed since the boom in electric traction began in this country. The London County Council, in their latest specification, were insistently demanding machine-fitted trucks, and the demand should soon become general.

The question how much machinery was necessary to construct a truck properly a very pertinent one. The journals and journal brasses, although they had often run hot and the manufacturer had been accused of bad workmanship on their account, owed their deficiencies to the parsimony of their buyers. The reason that they wore out at one end or one side, and tapered the journals, was that the inside of the journal box had not been properly machined, but had been fitted into the truck just as it came from the foundry.

The proper method of machining and attaching the various members of a truck not only gave a full fractional grip of the bolts, but made it possible at the same time to erect a truck which was in perfect [illegible] with [illegible]

[illegible] upon any particular member [illegible] was invariably the case in a truck which was erected with- [illegible] which had to be forced in square.

GOOD MACHINING NECESSARY.

Special attention should be given to the various members of the brake rigging. All the wearing-bolts should be carefully case-hardened, and some should even be arranged with movable bushes carefully case-hardened, and so placed that they could be easily removed when excessive wear had taken place. Of course all the bolts and pins should also be carefully machined and hardened. These remarks were applicable to all types of trucks, but in bogie trucks, either equal or unequal wheeled, careful attention should also be given to the perfect machining of the bolster housings where they attach to the side frames of the trucks, as well as to the bolster itself. Of course the idea was to machine only those parts which actually improved the qualities of the trucks as well as increased their life. It seemed unnecessary to add that the matter of machining could be carried to a ridiculous length, which meant unnecessary cost without getting any equivalent in the way of increased life or comfort.

In the case of the rigid wheel-base truck, he was not sure that it would be wise to machine either the outsides of the boxes or the inside of the horn block, for the reason that the best experience demonstrated that it was advisable to have a considerable amount of lost motion at these points, especially if the wheel-base of the truck was rather long for the radii of the curves.

THE CAR UNIT.

He believed all were agreed that, as a general proposition, the car unit, as represented by the ordinary single-truck car, was in most cases too small, and in a great many cases the car unit, as represented by the bogie or double-truck car was too large. In the case of bogie cars, the first cost had to be considered as well as maintenance, and the general rule had been to use two motor equipments, thus reducing the amount of adhesion available for traction purposes by from 20 to 30 per cent. The advantages of the bogie cars were, of course, that a larger car unit was possible than with the rigid wheel-base truck, and a better riding car; while the advantages of the single-truck car were, of course, its cheaper first cost, and the fact that it gave 100 per cent. traction efficiency.

The radial truck combined, in his opinion, the best qualities of both these types of trucks, while excluding all the disadvantages found in either type. It could be adapted to any size of car, ranging in length from 14 ft. to 32 ft.

In the case of the shorter cars, its first cost was about 75 per cent. greater than the ordinary rigid wheel-base truck; but where it displaced bogie trucks, the first cost was not only less, but it gave the full traction efficiency of the rigid wheel-base truck, and the splendid riding qualities of the bogie trucks, and by the application of only two motors. In addition to this, it had not the destructive effect on permanent way or special work unavoidable with the rigid wheel-base truck, neither was it wearing out eight wheels, four axles, eight brake shoes, or in many ways costing the same amount to maintain as in the case of the pair of bogie trucks.

THE RADIAL TRUCK.

In the case of steel-tyred wheels, on the radial truck the flanges might be thicker than upon the rigid wheel-base trucks, for the reason that the radial action gave a much better clearance at curves. This was a most important factor, as generally it was the lack of sufficient material in the wheel flanges owing to the narrowness of the grooved rail, that caused so much annoyance and expense in the maintenance of wheels.

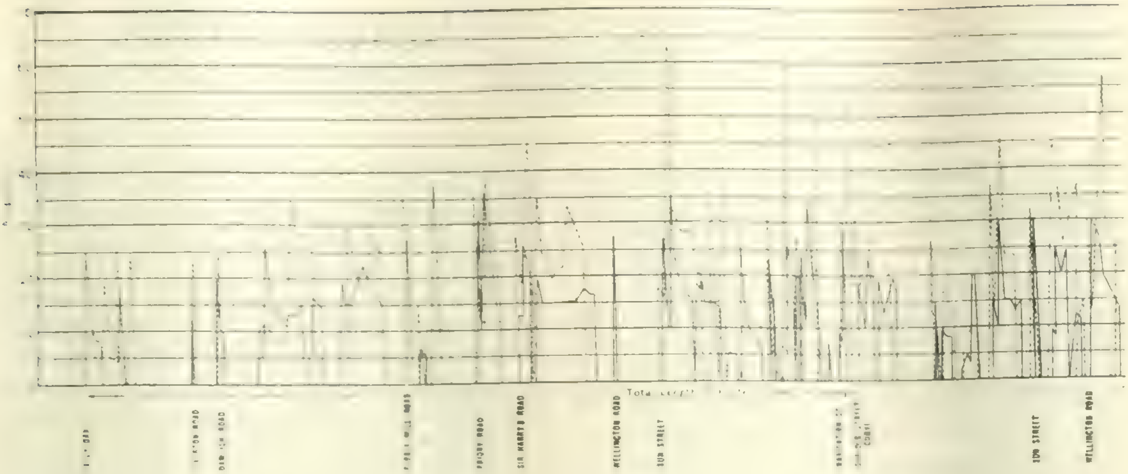
Last but not least of the many advantages of radial trucks was the saving of current. The truck having no work to perform in the direction of tearing up permanent way, and by its working principle having almost entirely obviated the friction at curves and turnouts, it logically followed that a saving in current would take place.

THE DISCUSSION.

Mr. Peckham, who opened the discussion, objected to the statement that there had been no improvements made in electric traction trucks in the last six years, as he himself had made improvements during the last year and a half that enabled him to handle successfully a 24-ft. car body on a 6-ft. wheel base. He had always been a believer in the cantilever truck, which properly supported the overhanging of the car body. He had tested the radial truck a good many years ago.

Mr. Cooke wished to know what radius could comfortably be taken by a radial truck corresponding to a car which would be taken by an ordinary 6-ft. wheel-base, rigid truck.

Mr. Mountain said there was a desire in the manufacture of trucks to have everything as well built as possible, but the prices paid would not permit of this. He thought he might mention that the trucks which were being built for the London County Council at the present time, were a great improvement on what had gone before. The design provided for the levelling up of the brass in such a way that it had a free rocking



PART OF A CHART SHOWING COMPARATIVE TESTS OF TWO SIMILAR CARS, ONE FITTED WITH A RADIAL TRUCK, THE OTHER WITH A RIGID TRUCK.

The tests were carried out between Selly Oak and [illegible] and back.

——— Car fitted with radial truck. ………… Car fitted with rigid truck.

[illegible] which [illegible] strain and wear upon the brass, and almost centred the whole strain or weight of the car exactly in the position of the axle boxes where it was required. He would urge upon tramway managers the necessity of treating the truck as a mechanical appliance. His experience had been that to machine a horn block inside, was undoubtedly an important point. Although it was a very expensive method, it had been found that it added very much not only to the life of the truck but to the ease with which it ran.

THE PROBLEM OF PERFECT RADIATION.

Professor Carus Wilson said he happened to know at the present time of more than one light railway in this country, in which a successful radial truck would practically be a solution of the financial difficulties involved in getting the line built. That type of truck should also be useful in negotiating curves in towns, and he believed the radial truck had come to stay. At the same time he had not yet been satisfied that a radial truck had been designed, which would go properly under all conditions of running. It seemed to him to be an exceedingly difficult problem.

Questions also arose in connection with the centrifugal action, but if the motor can be arranged on the outside and counterbalanced the centrifugal action of the car body, that would be a step in advance. Then there was the difficulty of getting perfect radiation in a radial car. In the case of going round a curve of a certain radius, the angular displacement of the radial truck, with the centre line of the car body, was a fixed quantity quite independent of the speed, and some kind of spring arrangement was necessary to bring the truck back into its central position when it was off the curve. You had to adjust the strength of the spring to what theoretically were impossible conditions, for it was clear you could not get a spring that would give the same amount of pull and keep the proper radiation at two different speeds on the same curve or at the same speed on two different curves. It was a very difficult problem, and it must be admitted that the very best radial car that had been made would only radiate at certain specified speeds and curves. He thought it was a mistake to assume that radial trucks were not going to effect any saving on the straight.

Mr. J. S. Warner said he knew in engineering of no class of service in which iron work was subjected to such trying conditions as had to be undergone by tramway car trucks. He was rather surprised that no one had mentioned the deflection of axles. Undoubtedly, tramway rolling stock was in need of improvement. It seemed to him that if one had a short truck, with a rigid wheel-base, driven over a central pivot, one was sure to get a lot of oscillation in that truck, unless the wheel-base was at least equal to the gauge. He would impress on tramway engineers that in designing a machine that had to work in mud and water, it was necessary to think in a very different way to when designing railway rolling stock.

Mr. Acland said he had advised the Chesterfield Corporation to adopt the radial truck. The sharpest curves in Chesterfield were 40 ft. radius from the inside rail, and they took those curves at a speed of four to five miles per hour only. The whole point of the radial truck was the giving of the car wheels on the curves, [illegible] careful investigations [illegible] of the truck.

RAIL CORRUGATION

[illegible] Hamilton said that in Leeds [illegible] among the earliest used [illegible] and which had been [illegible] the autumn of 1897. Out of [illegible] were then supplied [illegible] nothing like [illegible] the rough overhauling [illegible] did not bear out the view [illegible] Mr. [illegible] that the life of such a truck was [illegible] In view of the agitation for higher speeds, it was clear these could only be obtained if tramway managers were prepared to have proper trucks put under the cars. Salvation lay in that direction. Latterly, a sub-committee at Leeds had been inquiring into rail corrugation, which in the old days of the horse tramway was practically unknown. It was a curious thing that the principal rail corrugation occurred on flat curves, curves of a 100 to 150 ft. radius on the outside rail, and he wondered if there was anything in the action of the car which caused this corrugation.

The author, in replying on the discussion, stated that with regard to the possible wheel-base on a minimum curve, he would not, on a 30-ft. radius curve, think of running anything greater than a 6-ft. 6-in. rigid truck, but it was perfectly possible to run an 8-ft. 6-in. radial truck on the same track. At 40 ft. the wheel-base could be increased to 10 ft., and at 50 ft. to 11 ft. or 12 ft. The idea of the radial truck was really taken from the leading bogie wheels of the English locomotive, but when applied to electric traction, the imperfect understanding of the problem leads to some difficulties. He thought that Professor Carus Wilson seemed to be labouring under a misapprehension as to the spring arrangement, which was put on more to prevent "hunting" than to prevent the truck overhanging when it came out of the curve. As to the difference between practical and theoretical radiation, it was certain in practice that the radiation took place without any cutting or grinding. There remained that slip and glide which was a feature in all fixed wheels, or wheels on fixed axles, a difficulty which was neither accentuated, nor decreased in the radial truck. It would be admitted, however, that if it were possible to run an 8 ft. 6 in. wheel-base without increasing other troubles, it was an advantage. In regard to the question as to life of trucks, of course, it was possible that a truck which became useless in five years on one line, would last ten or fifteen years on another line.

NEWS ITEMS.

A committee of the North of England Institute of Mining and Mechanical Engineers has been appointed to make arrangements for the reception of the members of the American Institute of Mining Engineers on their visit to the district at the end of July.

The armoured cruiser *Tsukuba* was successfully launched on Tuesday at Kure, this being the first armoured cruiser built entirely in Japan without aid from abroad. In speeches delivered at the ceremony sincere recognition was made of the debt Japan owes to British tuition in shipbuilding.

For the latest Cunarder now in course of construction Messrs. Brown, Lennox and Company, of Pontypridd, South Wales, are manufacturing the largest cable as yet made for ships' use. The iron is 3⅞ in. diameter at the smallest part of the link; each link measures about 22½ in. in length, and weighs with the crucible cast steel stud about 160 lb.

The annual distribution of the certificates awarded to students of the Crystal Palace Company's School of Practical Engineering was held on the 21st inst., Sir William Mather in the chair. The certificate of honour was awarded to G. O. Sharpe, and the Wilson Premium to W. L. Wilkinson for a paper read before the Crystal Palace Engineering Society on "Building and Road Construction in India."

According to the annual report of the Parsons Marine Steam Turbine Company, turbine engines to the extent of 382,500 horse-power are now under construction in the United Kingdom. It is only four years since the first turbine passenger steamer began to run, and already the turbine engines under construction form a large proportion of the marine steam-engines that are being built. Thirty-eight shipbuilding and engineering companies have taken out licences from the Parsons Company to construct turbine engines. Fourteen of these companies are in England, nine in Scotland, four in the United States, two in Ireland, and one each in Canada, Japan, Germany, Italy, Holland, Belgium, Austria, France, and Scandinavia. Three Cunard steamers, two of them over 30,000 tons and one over 20,000 tons, and two Allan steamers each of about 15,000 tons, are building, and will be fitted with turbine engines, and these five represent more than the indicated horse-power of all the rest of the turbine steamers now building in any part of the world.

CIVIL ENGINEERING PROJECTS IN THE STATES.

THE [illegible] of the year, in which prominence is given to civil engineering projects in the States and elsewhere. As regards the Panama Canal our contemporary is very frank. [illegible] the Panama Canal if we state that this is one of the most serious problems—political, commercial, or military—confronting this country to-day; nor shall we be accused [illegible] the way in which we have handled this great problem during the past few months has added nothing to our reputation for constructive and executive ability in a work of this magnitude. There have been resignations without number, including that of the chief engineer; we have appointed boards of control, only summarily to disband them; we have spent ten million dollars, even before we know what kind of a canal we intend to build, or by what particular method we will build it; and finally, after calling together an advisory board composed of the most representative engineers of the world, in order that they may tell us just what kind of a canal we should construct, we are hysterically threatening to ignore their decision even before they have had time officially to render it. The Scientific American is of the opinion that there are just three things for the United States to do if it is to maintain its national dignity and successfully carry through this gigantic work: the first is to accept without question the type of canal recommended by the board; the second is to let the whole work by contract, under the absolute supervision of a chief engineer; and the third is to vote him ungrudgingly the appropriations which are necessary to carry on the work upon the scale and by the methods that he shall determine. If this be done, the United States within a single decade will possess a sea-level canal deep enough and broad enough for any possible development in the size of the ships of the future, and capable of giving them unhindered passage from the Atlantic to the one tidal lock on the Pacific. Moreover, if these conditions are fulfilled, they are satisfied that a sea-level canal will be placed at the service of the country in practically the same time as one built with locks and having the same capacity."

In the *résumé* of civil engineering, attention is called to the truly "marvellous development" in the use of armoured concrete construction, and the opinion is [illegible] ful influence within the field of the civil engineer than [illegible] Bessemer steel.

[illegible] with the exception of the Blackwell's Island Bridge across the East River, New York, the great structures planned across that river have made but little progress. The Blackwell's Island Bridge is completed as to its substructure, and the superstructure is now in course of erection. The Manhattan Suspension Bridge, after two years of delay, has been switched [illegible] structure, is at a standstill.

The completion of some highly-interesting tunnel work is recorded. A most important event of the year was the completion of Chicago's freight, express, and mail subways; for upon the successful operation of the system will depend its extension to other cities.

During the latter part of the year gratifying progress has been made in dredging the great Ambrose Channel, 7 miles in length and 40 ft. in depth, which [illegible] to New York Harbour.

The [illegible] the protection of that city against a repetition of the disaster of September 8th, 1900, was completed during the year, and the work of filling in back of it, and thereby raising the grade of the city, has been steadily carried on. An interesting coincidence in the field of civil engineering is the completion during the year of the two largest modern reservoirs built for city water supply—namely, the Wachusett reservoir for the supply of the city of Boston, and the new Croton reservoir for the supply of New York city. The Wachusett reservoir dam extends 129 ft. above ground level and 158 ft. above its lowest foundation, and it impounds 63,000,000,000 gallons of water. The Croton extends 157 ft. above ground level, 297 ft. above its lowest foundation, and it impounds 32,000,000,000 gallons. The Jerome Park reservoir, in New York, easterly basin has now been fully concreted, and is ready to receive water. The important task of providing additional water supply for the future needs of New York city has been advanced by the passing of the necessary legislation. The Board of Water Supply has presented a report of the plan of its engineers to secure a daily additional supply of from 500,000,000 to 600,000,000 gallons of water.

CONTRACTORS' NEWS.

We shall be pleased to insert under this column, free of charge, particulars of open contracts.

CONTRACTS OPEN.

Last Day

Manchester.—Laying underground telephone pipes (Contract No. 12) with other [illegible] works, for the Special Committee [illegible] Telephones. City Surveyor's Office, Town Hall, Manchester ... ... Jan. 2

London, E.C.—For the supply and delivery of deck bridges (about 60 ft. in the clear) for the East Indian Railway Company, as per specification to be seen at the Company's offices. Mr. C. W. Young, secretary, Nicholas Lane, London, E.C.... Jan. 3

Hamilton (Scotland).—For the removal of the present bridge carrying the Sand- [illegible] highway over the Kype Water, and the construction of a new steel girder bridge in lieu thereof, for the District Committee of the Middle Ward of the County of Lanark. Mr. W. L. Douglass, district engineer, District Offices, Hamilton ... ... Jan. 5

Grimsby.—For plant, buildings, and cables to the following specifications, for the Corporation: (Specification No. 35) engine and dynamo—500 k.w. continuous-current dynamo direct-coupled to high-speed double-acting engine; (36) water-tube boiler and underfeed stokers; (37) extension of switchboard; (38) condensing plant—surface type; (39) buildings—bills of quantities for extension of engine-room, new coal bunkers, and new store; (43) pipework; (44) coal-conveying plant—two scraper conveyors and one elevator; (45) supply of cables (lead-covered, paper-insulated). Mr. W. A. Vignoles, borough electrical engineer, Corporation Electricity Works, Grimsby... Jan. 5

Leyton, (Essex).—Construction of nine miles of double tramway track, and for all materials connected therewith, for the Leyton Urban District Council. Mr. William Dawson, M.Inst.C.E., surveyor, Town Hall, Leyton ... ... Jan. [illegible]

Bristol.—Supplying, fixing, setting, and mounting of two Cornish boilers, 5 ft. 6 in. diameter and 15 ft. 6 in. long, at their workhouse at Eastville, and removal of two boilers now in use, for the Guardians. Mr. J. J. Simpson, clerk, St. Peter's Hospital, Bristol ... ... Jan. 8

Southsea.—Extension of pier, for the Southsea Clarence Esplanade Pier Company. Mr. Alfred H. Bone, C.E., engineer, 148, High Street, Portsmouth... Jan. 10

West Hartlepool.—For the works required in connection with the reconstruction of No. 4 graving dock, West Hartlepool, for the North-Eastern Railway Co. Mr. T. M. Newell, engineer, Dock Office, Hull ... ... Jan. 10

Last Day

London.—Supply and delivery of about 2,300 tons of steel slot rails required in connection with the reconstruction for electrical traction on the conduit system, of certain of the Council's tramways North of the Thames, for the London County Council. Engineer's Department, County Hall, Spring Gardens, S.W. ... ... Jan. 16

Nelson. — Construction of an inclined retort stack (36 mouthpieces) with all hydraulic mains, stage floors, coal conveyors, charging apparatus, etc., in the existing retort house at their Brierfield works, for the Gas Committee. Mr. A. J. Hope, engineer, Gas Offices, Nelson. Jan. 17

Stratford-upon-Avon.—Manufacture delivery, and erection of three sets of gas or oil engines and pumps, for the Corporation. Messrs. Willcox and Raikes, Union Chambers, 63, Temple Row, Birmingham ... ... Jan. 22

London, E.—Reconstruction of a swing-bridge carrying Old Gravel Lane over the entrance to the East London Dock, in the metropolitan borough of Stepney, for the London County Council. Mr. Maurice Fitzmaurice, C.M.G., County Hall, Spring Gardens, S.W. ... ... Jan 23

Great Northern Railway.—Construction of Contract No. 1 from Enfield to Cuffley, being a length of five miles or thereabouts, for the Great Northern Railway Company. Engineer of the Company, King's Cross Station, London, N ... ... Jan. 23

COMING CONTRACTS.

Shrewsbury.—The Town Council have decided to proceed with the Castle Pulverbatch upland water scheme by the promotion of a Bill in Parliament. The engineer's original estimate for the scheme amounted to £148,000, but the proposed acquirement of the watershed will increase this sum by £10,000.

Penzance.—An inquiry has been held into the application of the Town Council to borrow £4,500 for works of water supply.

St. Pancras.—The Borough Council propose to apply to the London County Council for sanction to a loan of £12,150 for electric lighting purposes.

Leeds.—The City Council have approved of the recommendation of the Sewerage Committee to purchase 1,000 acres of land in the neighbourhood of the sewage works at Knostrop at the price of £231,000, subject to the Corporation obtaining powers to use the grounds for he purpose of sewage disposal.

Portsmouth.—The [illegible] additional plant for working the [illegible] been agreed to. The estimated cost [illegible] is as follows: Engine, generator, boiler [illegible] pumps, economiser, condensing plant [illegible] additions to switchboard, sinking well, laying negative return feeder, and providing 16 double-decked cars, £20,800. The proposals have been adopted by the Council.

CONTRACTS CLOSED.

South-Eastern Railway.—The contract for the removal of the old roof and the rebuilding of Charing Cross Station has, it is stated, been let to Messrs. Handysides, Limited, of Derby.

London County Council.—The London County Council have accepted the following tenders. For the supply, delivery, and erection of steelwork for Greenwich Station: E. C. and J. Keay, £46,490; roadwork in Vauxhall Bridge Road: J. Mowlem and Co., £2[illegible].

Glasgow.—The Electricity Committee recommend the following tenders for acceptance: Willans and Robinson, three turbine-driven generators, £43,717; British Westinghouse Co., seven sets of motor-generators and double balancing attachments, £17,850; and high-tension switchboards and instruments, £8,7[illegible]; Bruce Peebles and Co., two sets of motor-generators and double balancing attachments, £5,000; Ferranti Ltd., low-tension switchboards, £1,398; Babcock and Wilcox, ten boilers for Port Dundas and St. Andrew's Cross Stations, £10,71[illegible].

London.—The Underground Electric Railways Co., of London, has placed an order with the American Car and Foundry Company for about 200 cars for the Charing Cross, Euston and Hampstead Railway.

Gateshead-on-Tyne.—Messrs. Clarke, Chapman, and Co., Ltd., of Gateshead-on-Tyne, are now executing contracts for [illegible] large air capstans for the Admiralty, and a complete outfit of auxiliary machinery—namely, winches, windlasses, cranes, capstans, main and auxiliary pumps—and the electric light installation for the four large P. and O. first-class passenger steamers.

Admiralty.—The Admiralty contracts for the construction of the three armoured cruisers have been placed with Messrs. John Brown and Co., Clydebank, the Fairfield Company, Govan, and Sir W. G. Armstrong, Whitworth, and Co., Newcastle-on-Tyne.

Elland.—Robert Dempster and Co., Ltd., of Elland, are supplying the Rhondda Urban District Council with a steel tank and gasholder, 80 ft. in diameter, prepared for three lifting, complete with foundations, etc.

Croydon.—The Town Council has accepted the tender of the British Thomson-Houston Co., Ltd., for the supply of a three-machine motor-generator, at £1,45[illegible].

War Office.—The Haste Pump Co., Ltd., have received orders from the War Office for three sets of surface condensing plant of the counter-current type, including Edwards patent air pumps; also a separate contract for a large direct-acting steam pumping engine.

Newcastle.—Messrs. R. and W. Hawthorne, Leslie, and Co., Ltd., [illegible] Forth Banks Locomotive Works, Newcastle, who recently delivered three powerful "Mogul" type locomotives to the Eastern Argentine Railway, have quite recently completed a contract for four large "Consolidation" type freight engines for the Gold Coast Government Railways.

Mexborough.—A contract for 16 double-deck car bodies for Mexborough (National Electric Construction Co.) has been placed with the Brush Electrical Engineering Co., Ltd.

Dundee.—The Ferbeck Chimney Construction Co., has secured the contract for the erection of the chimney shaft (constructed on the company's patent system) for the Dundee tramway power station.

APPOINTMENTS VACANT.

Aberdeen.—The Town Council have decided to appoint a general manager, at £300 per annum, to take charge of the tramway undertaking, including rolling stock, but exclusive of electrical and mechanical equipment and permanent way ... ... —

Stockport.—Assistant gas engineer at a commencing salary of £120 per annum, rising, at the discretion of the gas committee, to £200 per annum. Mr. Robert Hyde, town clerk, Stockport ... .. Jan. [illegible]

Salford.—An assistant lecturer in mechanical engineering is required at the Royal Technical Institute, Salford ... ... Jan. 1[illegible]

Newcastle.—A lecturer in physics is required at Armstrong College, Newcastle-on-Tyne. Salary £200, rising by annual increments of £10 to [illegible] ... ... Jan. 13

Bradford.—The Corporation invite applications for the appointment of three engineering assistants in the sewage works, engineer's department, at a salary of £150 each per annum. Mr. Frederick Stevens, town clerk, Town Hall, Bradford... . Jan. 16

Auckland, New Zealand.—Applications are invited for the appointment of City Engineer to the City of Auckland. High Commissioner for New Zealand, Westminster Chambers, 13, Victoria Street, London, S.W. ... Feb. 8

APPOINTMENTS FILLED.

South Wales.—Mr. W. A. Chamen (of Messrs. Bramwell and Harris, and late chief engineer of the Glasgow Corporation Electricity Works) has been appointed manager of the South Wales Electrical Power Distribution Company in succession to Mr. Hill, who recently resigned.

Birmingham.—Mr. J. P. Kemp has been appointed resident engineer at the Summer Lane station of Birmingham Corporation electricity department.

Midland Railway.—Mr. W. C. Ackfield, of the London, Brighton, and South Coast Railway, has been appointed signals superintendent of the Midland Railway, in succession to Mr. T. W. Woodward, retired.

Johannesburg.—Mr. J. Foster has been appointed car-shed superintendent by Johannesburg Municipal Council.

Share List of Engineering, Electrical, Iron and Steel, and other Companies.

The following is a comprehensive list of Companies in the industries covered by "Page's Weekly," in which shares business is being currently transacted. Additions will be made from time to time as occasion requires. We desire it to be understood that while our Share List will generally be found correct, we do not hold ourselves responsible for any loss or inconvenience that may arise from possible inaccuracies

STOCK EXCHANGE SETTLING DAYS.—Settling days on the Stock Exchange are as follows:—
Consols Jan. 4th General Settlements: Dec. 29th; Jan 11th, 25th; Feb 8th. Bank Rate, September 28th, 1905, 4 per cent.

I.—ENGINEERING, IRON, AND STEEL COMPANIES.

Present Amount Subscribed	Shares	Last Dividend	Name.	Paid up	Closing Prices
11,370	[illegible]	5/-	Alldays & Onions Pneumatic Engineering, Ltd.	3	[illegible]
10,000	5	3/-	Do. Cum. Pref. 6 per cent. ..	5	4½ – 4[illegible]
8,210,000	1	1	Armstrong (Sir W. G.), Whitworth and Co., Ltd.	1	3⅜ – [illegible]
76,970	5	2/-	Do. 4% Cum. Pref.	5	5[illegible] – 5⅝
1,500,000	100	4	Do. 4% 1st Mort. Dbs. Rd.	100	103 – 10[illegible]
£100,000	100	4½%	Aveling and Porter, Ltd., 4½% Reg. Mt. Debs Red.	100	96 – [illegible]
530,000	1	1/7½	Babcock and Wilcox, Ltd., Ord. ..	1	[illegible] – 4
100,000	1	7½d.	Do. ,, 6% Cum. Pref.	1	1[illegible] – 1 9/16
20,000	5	3/-	Baker (Joseph) and Sons, Ltd., 6% Cum. Pref.	5	5 – 5¼
250,000	1	6½d.	Baldwins, Ltd., 5½% Cum. Pref. ..	1	1[illegible] – 1[illegible]
£250,000	Stk	4½%	Do. 1st Mt. 4½% Deb. Stk. Red.	100	102 – 104
150,000	4½	[illegible]	Barrow Hæmatite Steel Co., Ld., O.	4½	5 – [illegible]
50,000	4½	3	Do. do. Cum 2nd. Pref.	4½	5 – [illegible]
83,334	5	2/6	Bayliss, Jones and Bayliss, Ltd., 5% Cum. Pref. Shares	5	4¾ – 5¼
£500,000	100	4½%	Beardmore (Wm.) & Co., Ltd. 4½% 1st Mt. Debs., Red., Scrip 50% pd	—	104 – 10[illegible]
50,000	10	6/-	Bell Brothers, Ltd., 6% Cum. Pref.	10	12¾ – 1[illegible]
£366,600	Stk	4%	Do 4% Deb. Stock, Red.	100	100 – 102
200,000	1	1/-	Beyer, Peacock and Co., Ltd., Ord.	1	[illegible]
300,000	1	6¾d.	Do. 5½% Cum Pref.	1	[illegible]
£300,000	Stk	4½%	Do. 4½% Red. Deb. Stock	100	93 – 9[illegible]
1,629,760	1	6d.	Bolckow, Vaughan and Co., Ltd., O. Nos. 1-1,629,760	1	1 – 1[illegible]
1,860,900	1	3½d.	Do. Nos. 1,639,101-3,500,000	12/-	[illegible]
1,160,000	1	4½d.	Brown (John) and Co., Lim., Ord., Nos. 1-1,160,000	15/-	1[illegible] – 1[illegible]*
590,000	1	6d.	Do. Ord., Nos. 1,160,001-1,750,000	1	1⅛ – 2
74,000	10	5/-	Do. 5% Cum. Pref.	10	11[illegible] – 12*
154,500	5	2/6	Cammell, Laird & Co., Ltd., Ord. ..	5	1[illegible] – 10[illegible]
252,500	5	2/6	Do. 5% Cum. Pref. ..	5	5¼ – [illegible]
450,000	1	1/2½	Clayton & Shuttleworth, Ltd., Ord.	1	[illegible]
70,000	5	2/6	Do. 5% Cum. Pref	5	5[illegible] – [illegible]
£250,000	Stk	4%	Do 4% 1st Mort Db. Stk. Red	100	100 – 102
100,000	10	30/-	Consett Iron Co., Ltd., Ord.	7½	35 – 36
57 031	10	10/	Crossley, Bros., Ld., Ord 40340/97370	10	[illegible] – 1[illegible]
40,339	10	5%	Do. 5% Cum. Pref.	10	11 – 11[illegible]
75,000	1	2/6	Delta Metal, Ltd. Shares	1	2¼ – 2[illegible]
1,259,594	1	3½d.	Dorman, Long & Co., Ltd.	1	[illegible]
£400,000	Stk	4%	Do. 4% 1st Mort. Perp. Deb. Stk.	100	[illegible] – 96
200,000	5	5/	Dunderland Iron Ore Co., Ltd., 6% Cum. Pref. and Participating ..	5	[illegible] – 4¼
250,000	1	9¾d.	Dunlop (James) & Co., Ltd., Ord...	1	[illegible]
300,000	1	7½d.	Do. 6% Cum. Pref. ..	1	
4,721	13	13	Ebbw Vale Steel, Iron & Coal Co., Ltd.	13	10½ – 11½
69,754	13	10/	Do. do. do.	10	9 – 9[illegible]
20,250	10	8/-	Elliott's Metal, Ltd.	8	5 – 5¼
5,000	10	5%	Do. Cum. Pref. 5%	10	[illegible] – 9½
186,748	Stk	4%	Do. Deb. 4%	100	90 – 94
25,000	10	6/-	Fairfield Shipbuilding & Engng. Co., Ltd., 6% Cum. Pref. ..	10	11½ – 1[illegible]
£250,000	Stk	4½	Do. 4½% Mort. Deb. Stk. Red.	100	100 – 103
126,000	3	2/1½	Fraser & Chalmers, Ltd., Ord. ..	3	3[illegible] – [illegible]*
21,000	3	1/6	Do. 7½% Cum. Pref.	3	5¾ – [illegible]
10,000	10	5%	Galloways, Ltd., 5% Cum. Pref. 18001/28000	10	7¼ – [illegible]
£160,000	Stk	4%	Do 4% 1st Mort Deb Red. .	100	[illegible]
16,800	10	10/-	Greenwood & Batley, Ltd., Ord. ..	10	6½ – 7
9,600	10	7%	Do. 7% Cum. Pref.	10	10[illegible] – 11¼
965,000	1	1/-	Guest, Keen & Nettlefolds, Ltd. Ord.	1	2[illegible] – 2[illegible]
344,000	5	2/6	Do. 5% Cum. Pref.	5	6[illegible] – 6⅝
£1,850,500	Stk	4%	Do. 4% Irred. Mort. Deb. Stk	100	106 – 108
18,000	5	2/6	Gwynnes, Ltd., 5% Cum. Pref. ..	5	2[illegible] – 3¼
250,000	1	1/-	Hadfield's Steel F'dry Co., Ld., Ord.	1	¾ – 1
20,000	10	4/6	Do. 4½% Cum. Pref.	10	10[illegible] – 11¼
30,000	5	3/-	Hall (J. & E.), Ltd. 6% Cum. Pref...	5	[illegible]
408,505	1	1/6	Harvey United Steel Co., Ltd. ..	1	¾ – 1
47,500	10	7½%	Hawthorn, Leslie & Co., Ltd. Ord.	10	98 – 100
28,001	5	7/	Head, Wrightson & Co., Ltd. ..	5	5[illegible] – [illegible]
85,000	1	7½d.	Hill (Richard) & Co. (1899) Ld., Ord.	1	[illegible] – ⅞
18,000	5	3/	Do. 6% Cum. Pref.	5	[illegible]
£100,000	Stk	6%	Hornsby (Richard) & Sons, Ld., Ord. 6% Cum. Pref.	100	104 – 10[illegible]*
750,000	1	7½%	Howard & Bullough, Ltd., Ord. ..	1	1 9/16 – 1 11/16
25,000	10	6/-	Do. 6% Pref. (Non-Cum.) ..	10	12½ – 13
£250,000	Stk	4%	Do. 4% Deb. Stk., Red. after 1905	100	98 – 101
37,500	10	20	Kynoch, Ltd.	10	18¼ – 18⅜
49,537	10	5%	Do. Cum. Pref. 5%	10	10⅜ – 10⅞
300,000	1	4⅜d	Lambert Bros., Ltd., Ord.	1	⅝ – ⅞
50,000	5	2/9	Do. 5½% Cum. Pref .. .	5	4¼ – 4¾
40,000	3	2/1½	Leeds Forge Co., 7% Cum. Pref. ..	3	4 – 4½
200,000	1	7½d	Lysaght (John), Ltd., 6% Cum. Pf.	1	1 5/16 – 1 7/16
£300,000	Stk	4½%	Do 4½% 1st Mt Deb. Stk., Red.	100	110 – 112
40,000	10	5/-	Mather & Platt, Ld., 5% Cum. Pref	10	11¼ – 11¾
210,000	1	8¼d.	Measures Bros., Ltd., Ord.	1	1 – 1⅛
75,000	1	6⅜d.	Do. 5½% Cum. Pref.	1	15/16 – 1 1/16
£75,000	Stk	4½%	Do. 4½% 1st Mrt. Db. Stk., Red.	100	98 – 101
21,943	5	2/6	Muntz Metal, Ltd.	5	4¾ – 5¼
14,248	5	5%	Do. Pref. 5%	5	4¾ – 6¼
5,000	62½	47/6	Nantyglo and Blaina Iron Works, Ltd., 8% Cum. Pref.	62½	78 – 81
73,000	10	5/-	N. Brit. Loco. Co., Ltd., 5% Cm. Pf.	10	12⅛ – 12⅝
80,000	5	—	North-Eastern Steel Co., Ltd.,		
£250,000	Stk	4½%	4½% 1st Mrt. Db. Stk., Red.	100	89 – 93
122,000	5	1/6	Pearson & Knowles Coal and Iron Co., Ltd., Ord., "B"	5	5 – 5½
50,000	5	3/-	Do. 6% Cum. Pref. "A" ..	5	6 – 6½
70,000	10	10/-	Pease & Partners, Ltd., Ord. .	10	13 – 13½
£400,000	Stk	4%	Do. 4% Perp. Deb. Stock	100	99 – 102
20,000	5	3/-	Peebles (Bruce) & Co., Ld., 6% Cm. P.	5	4⅞ – 5⅛
65,000	1	—	Pooley (Henry) & Son., Ltd., Ord ..	1	10/3 – 10/9
13,000	5	—	Do. 5½% Cum Pref. .. .	5	4⅜ – 4⅞
230,000	1	—	Projectile Co. (1902), Ltd., Ord. ..	1	[illegible]
126,938	5	2/-	Rhymney Iron Co., Ltd.	5	2[illegible] – 2[illegible]
73,062	5	2/-	Do. New	5	1¾ – 2
£330,000	—	5%	Do. 5% Mort. Deb., Red. ..	100	102 – 104
350,000	1	1/2½	Richardsons, Westgarth & Co., Ltd., Ord. 350,001—700,000 ..	1	15/16 – 1
£350,000	1	7⅛	Do. 6% Cum. Pref.	1	[illegible] – 1 1/16
£350,000	Stk	4½%	Do. 4½% Perp. Deb. Stock ..	100	98 – 101
35,000	10	12/-	Ruston, Proctor & Co., Ltd... ..	10	10½ – 11
275 000	1	6d.	Scott (Walter) Ltd., Ord.	1	⅞ – 1[illegible]
300,000	1	7½d.	Do. 6% Cum. Pref. ..	1	1 – 1 1/16
£300,000	Stk	4%	Do. 4% Perp. Deb. Stk.	100	94 – 97
£115,300	100	5%	Shelton Iron, Steel and Coal Co., Ld. 1st Charge 5% Debs., Red ..	100	94 – 97
£97,900	100	6%	Do. 6% 2nd Mort. Debs., Red.	100	98 – 102
250,000	1	1/-	South Durham Steel & Iron, Ltd. Or.	1	1⅛ – 1¼*
300,000	1	1/2½	Do. 6% Cum. Pref...	1	15/16 – 1 1/16
£300,000	Stk	4½%	Do. 4½% Per. Deb. Stock	100	93 – 96
25,000	10	—	Stephenson (Robert) & Co., Ltd., Or.	10	2¼ – 2¾
25,000	10	5/6	Do. 5½% Cum. Pref. ..	10	5 – 5½
£250,000	Stk	4%	Do. 4% Perp. Deb. Stock	100	80 – 83
85,000	10	9/-	Stewarts & Lloyds, Ltd., Ord. ..	10	19 – 19½
55,000	10	6/-	Do. 6% Cum. Pref.	10	14½ – 15
684,732	1	6d.	Swan, Hunter & Wigham-Richardson, Lim. Ord.	1	⅞ – 15/16
538,845	1	6d.	Do. 5% Cum. Pref.	1	15/16 – 1 1/16
£240,000	Stk	4½%	Do. 4½% 1st Mort. Deb. Stk. Red	100	96 – 99
300,000	1	6d.	Thames Iron Works, Shipbuilding & Engineering Co., Ltd., 5% Cum. Pf.	1	9/16 – 11/16
£200,000	100	4%	Do. 4% Irredeem. 1st Mort. Deb.	100	80 – 84
£148,500	1	7½d.	Thornycroft (John I.) & Co., Ltd. Or.	1	11/16 – 13/16
£160,000	1	7½d.	Do do. 6% Cum. Pref.	1	15/16 – 1 1/16
10,000	10	5/-	Tylor (J.) & Sons, Ltd. 5% Cum. Pf.	10	9¼ – 9¾
$508495200	$100	$½	United States Steel Corp. Com. Stk.	$100	38¾ – 39
$360814100	$100	$1¾	Do. 7% Cum. Pref. Stock	$100	106[illegible] – 107¼
$162268000	$1000	5%	Do. 10-60yr. 5% Skg. Fd. G. Bds.	$1000	99 – 101
3,850,000	1	1/-	Vickers, Sons & Maxim, Ltd. Ord..	1	2[illegible] – 2 11/16
750,000	1	6d.	Do. 5% Non-Cum. Pref. ..	1	1 3/16 – 1 5/16
£750,000	Stk	5%	Do. 5% Non-Cum. Pref. Stock.	106	121 – 124
£1,250,000	Stk	4%	Do. 4% 1st. Mort. Deb. Stk. Red.	100	103 – 105
£1,000,000	100	4½%	Do. 4½% 2nd Mort. Debs., Red.	100	103½ – 105½
225,000	1	1/2⅝	Weardale Steel, Coal & Coke, Ltd., Def. Ord.	1	1[illegible] – 1[illegible]
500,000	1	7½d.	Do. 6% Cum. Pref. Ord. ..	1	1⅛ – 1 3/16
£800,000	Stk	4%	Do. 4% Perpetual Deb. Stock	100	92 – 96
66,666	5	3/.	Willans & Robinson, Ord.	5	1¾ – 2¼
66,666	5	3/-	Do. 6% Cum. Pref.	5	3 – 3½
£246,641	Stk	4%	Do. 4% 1st Mort. Deb. Stk. Red	100	82 – 87
£150,000	Stk	4½%	Yorkshire Iron & Coal Co., Ltd., 4½% 1st Mort. Deb. Stk. Red.	10	77 – 79

Stocks and Shares marked * are quoted ex-dividend.

II.—ELECTRICAL MANUFACTURING COMPANIES.

Present Amount Subscribed	Shares	Last Dividend	Name	Paid up	Closing Prices
70,000	1	6d.	Alliance Elec. Co., Ltd., [illegible] Cum. Pf	1	[illegible]
12,[illegible]	1	7½d.	Aron Elec. Meter Ltd., [illegible] Pf	1	[illegible]
130,[illegible]	1	1/2½	Bell's Asbestos Co., Ltd.	1	1½ – 1⅝
£[illegible]	5	9d	British Aluminium Co., [illegible] Cum. Pref.	[illegible]	5¾ – [illegible]
£[illegible]	Stk	5%	Do. 5% 1st Mort. Deb. Stk. Rd	100	[illegible] –102
100,000	5	4/-	British Insulated & Helsby Cables, Ltd., Ord.	5	[illegible] – 7
100,000	5	3/-	Do. 6% Cum. Pref.	5	5½ – [illegible]
£500,000	Stk	4½%	Do. 4½% 1st Mort. Deb. Stk. Rd.	100	103 –106
£200,000	Stk	4½%	British Thomson Houston Co., Ltd. 4½% 1st Mort. Deb. Stk. Red...	100	98 –100
400,000	5	8/-	British Westinghouse Electric and Manufac. Co., Ltd., [illegible]% Pref...	5	1¾ – 2¼
£616,[illegible]	Stk	4%	Do. 4% Mort. Deb. Stk. Red...	100	80 – 85
105,731	2	2/-	Brush Elec. Enging. Co., Ltd., Ord..	2	[illegible]
15[illegible]	2	2/4½	Do. [illegible] Pref	2	1¼ – 1½
£12[illegible]	Stk	4½%	Do. 4½% Perp. 1st Deb. Stk.	100	96 –100
£1[illegible]	Stk	4½%	Do. 4½% Perp. 2nd Deb. Stk	100	84 – 86
35,000	5	5/-	Callender's Cable & Construction Co., Ltd., Ord	5	11 – 12
40,000	5	2/6	Do. 5% Cum. Pref. ..	5	5⅝ – [illegible]
£[illegible]	Stk	4½%	Do. 4½% 1st Mort. Deb Stk. Red.	100	10[illegible] – 111
[illegible]	3	1/6	Crompton & Co., Ltd.	3	2 – 2¼
£100,000	—	5%	Do. 5% 1st Mort. Reg. Debs.	100	97 –100
5[illegible],000	5	10/-	Dick, Kerr & Co., Ltd., Ord. ..	5	8½ – [illegible]
61,000	5	3/-	Do. 6% Cum. Pref.	5	5¾ – 6¼
£300,000	Stk	4½%	Do. 4½% Deb. Stock, Red.	100	106 –108
233,334	1	6d.	Doulton & Co., Ltd., 5% Cum. Pref.	1	1⅛ – 1⅜
£233,334	Stk	4	Do. 1st Mort. 4% Irred. Deb. Stk.	100	107 –110
99,261	5	1/6	Edison and Swan United Electric Light, Ltd., "A" Shares Nos. 1-99,261	3	1½ – 1¾
17,139	5	2/6	Do. "A" Shares Nos. [illegible] 017 139	5	2½ – 2¾
£344,023	Stk	4%	Do. 4% Deb. Stock Red.	100	85 – 90
£100,000	Stk	5%	Do. 5% Second Deb. Stk. Red.	100	92 – 97
112,100	2	1/7½	Electric Construction Co., Ltd. ..	2	[illegible]
31,390	2	2/9⅝	Do. 7% Cumulative Pref.	2	1⅞ – 2⅛
£200,000	Stk	4%	Do. 4% Perp. 1st Mt. Deb. Stk.	100	92 – 95
10,248	10	7/6	Evered and Co., Ltd.	10	9 – 11
25,000	10	5/-	Gen. Elect. Co. (1900), Ltd., 5% Cum. Pref.	10	9½ – 9¾
£[illegible]00,000	Stk	4%	Do. 4% 1st. Mt. Deb. Stk.. Red.	100	96 –100
35,000	5	5/-	Henley's (W. T.) Telegraph Works Co., Ltd., Ord.	5	12½ – 13½
35,000	5	2/3	Do. 4½% Cum. Pref	5	5⅛ – 5⅜
£50,000	Stk	4½%	Do. 4½% Mt. Deb. Stk. Red.	100	—
50,000	10	5/-	India Rubber Gutta Percha & Telegraph Works Co., Ltd.,	10	18½ – 19½
£300,000	100	4%	Do. 1st Mort. Deb. Red. ..	100	99 –102
7,500	10	—	Parker, Thos., Ltd. ..	10	6½ – 7
100,000	1	8%	Scott (Ernest) & Mountain, Ld., Ord.	1	17/3 – 17/[illegible]
37,350	12	12/-	Telegraph Construction and Maintenance Co., Ltd.	12	32 – 34
[illegible],000	100	4%	Do. 4% Deb. Bonds ..	100	102 – 104

III.—ELECTRIC TRACTION.

Present Amount Subscribed	Shares	Last Dividend	Name	Paid up	Closing Prices.
120,000	5	[illegible]	Anglo-Argentine Trams Co., Ld., Or.	5	[illegible]
2[illegible],007	5	2/6	Do. 5% Cum Pf.	5	5⅝ – 6½
£230,000	Stk	6%	Do. Permanent 6% Debenture Stock, 1888 ..	100	142 –145
20,000	10	12/-	Barcelona Trams Co., Ltd., Ord. ..	10	13¾ – 14¼
10,000	10	5/-	Do. 5% Cum Pf. Shares	10	9½ – 10
£46,300	100	5%	Do. 5% Debs., Red. ..	100	98 –101
£191,326	Stk	4½%	Do. 4½% Red. Deb. Stk.	100	97 –102
75,[illegible]	1	—	Bath Elec. Trams. Ld., Pf. Or.	1	[illegible] – 1
59,394	1	11·1d	Do. 5% Cum. Pf.	1	[illegible] – 1 1/16
75,000	5	—	Brisbane Electric Tram Investment Co., Ltd., Ord... ..	5	1 – 1½
75,000	5	2/6	Do. 5% Cum. Pf. ..	5	4 – 4¼
£425,000	Stk	4½%	Do. 4½% 1st Deb. Stk., Red.	100	95 – 98
£200,000	Stk	6%	Brit. Columbia Elec. Rly. Co., Ltd., Def. Ord. Stock	100	119–122
		5%	Pref. Ord. Stock	100	107–111
133,301	10	6/-	Brit. Electric Traction, Ltd., Ord.	10	7½ – 8½
156,437	10	6/-	Do. 6% Cum. Pref... ..	10	10 – 11
£1,000,000	Stk	5%	Do. 5% Perp. Deb. Stk. ..	100	117 –119
£250,000	Stk	4½%	Do. 4½% 2nd Deb. Stk. Red..	100	97 –99
100,000	5	2/6	Buenos Ayres & Belgrano Electric Trams, Ltd., Ord.	5	3⅜ – 3⅝
40,500	5	3/-	Do. "A" 6% Cum Pref. ..	5	5 1/16 – [illegible]
[illegible]7,000	5	3/-	Do. "B" do.	5	5 – 5½
£200,000	Stk	5%	Buenos Ayres Elec. Trams Co. (1901) Ltd., 5% Db. Stk., Red.	100	98–100
£220,000	100	6%	Buenos Ayres Gd. Nat., Ltd., 6% 1st Deb. Bds.	100	101–105

ELECTRIC TRACTION.—*Contd.*

Present Amount Subscribed.	Shares	Last Dividend	Name	Paid up.	Closing Prices
102,268	5	[illegible]	Calcutta Tramways Co., Ltd. ..	5	[illegible]
£350,000	Stk	4½%	Do. 4½% 1st Deb. Stk., Red.	100	107 –109
480,000	1	6d.	Cape Electric Tramways, Ltd. ..	1	[illegible] – 1⅛
40,000	5	[illegible]	[illegible] Trams Co., Ltd. 5% Cum. Pref.	5	4½ – [illegible]
£300,000	100	4%	Do. 4% 1st Mort. Debs. ..	100	100–103
£120,000	Stk	5%	Colombo Elec. Tram. & Light. Co., Ltd., 5% 1st Mort. Deb. Stk. Red.	100	101–103
60,000	10	[illegible]	Dublin United Trams. Co. (1896), Ltd., Ord. ..	10	13½ – 14½
59,987	10	6/-	Do. 6% Pref...	10	14½ – 1[illegible]
£125,000	Stk	4½	Hastings & Dist. Elec. Trams. Co., Ltd., [illegible] Deb. Stock, Red	100	101 –103
30,000	5	2/6	Isle of Thanet Elec. Trams. and Light. Co., Ltd., 5% Cum. Pref.	5	2¼ – 2¾
£150,000	Stk	4%	Do. 4% Deb. Stock.. ..	100	88 – [illegible]
125,000	10	[illegible]	London United Trams. (1901), Ltd., [illegible] Cum. Pref.	10	10 – 10½
£1,031,000	Stk	4%	Do. 4% 1st Mort. Deb. Stk. Red.	100	100–103
60,007	1	1	London Motor Omnibus Co., Ltd., Ord. No. 1—60,007 ..	1	1¾ – 2*
£50,000	Stk	[illegible]	Madras Electric Trams (1904), Ltd., [illegible] Deb. Stock, Red.	100	103 –105
314,016	1	—	Metropolitan Elec. Trams, Ltd., Def.	1	[illegible]
500,000	1	6d.	Do. 5% Cum. Pref... ..	1	1 – 1 1/16
£350,000	Stk	4½%	Do. 4½% Deb. Stock, Red.	100	106 –108
50,000	5	[illegible]	New General Traction Co., Ltd., [illegible] Cum. Pref.	5	½ – 1½
110,928	8	[illegible]	North Metropolitan Tramways Co..	8	4 – 4½
£150,000	100	3½%	Do. 3½% Mort. Debs.	100	93 – 98
£196,200	Stk	5%	Perth Electric Trams, Ltd. (W.A.) 5% 1st Mort. Deb. Stock, Red..	100	104 –107
24,500	10	10/-	Potteries Elec. Traction Co., Ld., Or.	10	8¾ – 9¼
24,500	10	5/-	Do. 5% Cum. Pref. ..	10	9¾ – 10¼
£220,000	Stk	4½	Do. 4½% Deb. Stk., Red.	100	103 –106
£160,000	Stk		Sunderland Dist. Elec. Trams. Ltd., [illegible] 1st Mort. Deb. Red	100	95 – 99
£275,000	Stk	12 11	Yorkshire (W. Riding) Elec. Trams. Co., Ltd., 4½% 1st Deb. Stk., Red.	100	96 – [illegible]

IV.—ELECTRIC LIGHTING AND POWER.

Present Amount Subscribed	Shares	Last Dividend	Name	Paid up.	Closing Prices
7,500	10	14/-	Bournemouth & Poole Elec. Sup. Co., Ltd., Ord. ..	10	12½ – 12⅞
7,500	10	4/6	Do. 4½% Cum. Pref. ..	10	10⅛ – 10⅝
7,500	10	6/-	Do. 6% Cum. Second Pf. ..	10	11¾ – 12¼
£70,000	Stk	4½%	Do. 4½% Deb. Stock Red ..	100	107 –109
14,000	5	3/6	Bromley (Kent) Elec. Lt. & Pr. Co. Ld	5	5¼ – 5¾
£50,000	Stk	4½	Do. do. 4½% 1st Deb. Stk. Red.	100	102 –105
27,507	5	4/6	Brompton & Kensington Elec. Supply Co., Ltd. Ord. ..	5	8[illegible] – 9[illegible]
12,493	5	[illegible]	Do. 7% Cum. Pref. Shares..	5	9 – 9¼
60,000	5	3/3	Calcutta Elec. Sup. Cor. Ltd., Ord..	5	9¼ – 9¾
£288,782	Stk	4	Central Elec. Sup. Co., Ltd., 4% Gua. Deb. Stk. ..	100	102 –105
70,000	5	2/6	Charing Cross & Strand Elec. Sup. Corp., Ltd., Ord... ..	5	5¾ – 6¼
80,000	5	2/3	Do. do. 4½% Cum. Pref...	5	5¼ – 5¾
£350,000	Stk	4%	Do. do. 4% Deb. Stk. Red.	100	101 –103*
41,436	5	2/3	Chelsea Elec. Sply. Co., Ltd., Ord.	5	5 – 6
£150,000	Stk	4½%	Do. do. 4½% Deb. Stk., Red	100	110 –112
70,595	10	7/-	City of London El. Lghtg. Co., Ld., O.	10	11 – 12
40,000	10	6/-	Do. 6% Cum. Pref.	10	13¾ – 14¼
£400,000	Stk	5%	Do. 5% Deb. Stk., Red ..	100	124 –128
£300,000	Stk	4½	Do. 4½% 2nd Deb. Stk., Red	100	108 –10[illegible]
40,000	10	4/-	County of London Elec. Supply Co., Ltd., Ord.	10	8½ – 9½
30,000	10	6/-	Do. 6% Cum. Pref.	10	12[illegible] – 12[illegible]
£400,000	Stk	4½%	Do. 4½% Deb. Stk., Red. ..	100	112 –115
70,000	5	2/6	Edmundson's Elec. Cor. Ltd., Ord.	5	5¼ – 5¾
70,000	5	3/-	Do. 6% Cum. Pref.	5	5¾ – 6
£300,000	Stk	4½	Do. 4½% 1st Mort. Db. Stk. Reg	100	107 – 109
£80,000	Stk	5	Electric Lighting & Traction Co. of Australia, Ltd. 5% Deb. Stk. Red.	100	87 – 92
10,000	5	[illegible]	Folkestone Elec. Supply Co., Ld., O.	5	5¼ – 5¾
£50,000	Stk.	4½	Do. 4½% 1st Deb. Stk., Red.	100	101 –104
15,000	10	—	Havana Electricity Co., Ltd... ..	10	9 – 10
13,000	5	6/-	Hove Elec. Lighting Co., Ltd., Ord.	5	8¼ – [illegible]
£50,000	Stk	4½%	Isle of Wight Electric Light & Power Co., Ltd. 4½% Deb. Stock, Red.	100	100 –103
150,000	1	—	Kalgoorlie Electric Power & Lighting Corp, Ltd., 6% Cum. Pref.	1	[illegible] – 1
21,000	5	5/-	Kensington and Knightsbridge Electric Lighting Co., Ltd., Ord. ..	5	10¾ – 11¾

Stocks and Shares marked * are quoted ex-dividend.

ELECTRIC LIGHTING AND POWER.—*Contd.*

Present Amount Subscribed	Shares	Last Dividend	Name	Paid up	Closing Prices
£135,000	Stk	4%	Kensington and Knightsbridge Electric Lighting Co., Ltd., and the Notting Hill Electric Lighting Co., Ltd., 4% Deb. Stock, Red.	100	98 —101
111,000	3	1/9	London Elec. Supply Corp., Ld., Ord.	3	1[illegible]— 2[illegible]
60,000	5	3/-	Do. 6% Pref.	5	4½
£371,895	Stk	4%	Do. 4% 1st Mort. Db. Stk., Red.	100	97 —100
100,000	10	[illegible]	Metropolitan Elec. Sup. Co., Ld., Or.	10	9½— 10½
76,121	5	2/3	Do. 4½% Cum. Pref.	5	5½— [illegible]
220,000	Stk	4½%	Do. 4½% 1st Mort. Db. Sk., Red.	100	109 —111
250,000	Stk	3½%	Do. 3½% Mort. Deb. Stk., Red.	100	97 —[illegible]
£250 000	—	4½%	Midland Elec. Corp. for Power Distribution, Ld., 4½% 1st Mort. Deb.	100	101—103%
10,852	10	8/-	Notting Hill Elec. Ltg. Co. Ltd. Ord.	10	13¾— 14¾
£59,000	100	4%	Do. 4% 1st Mort. Debs. ..	100	98 —100
16,500	5	2/6	Oxford Electric Co. Ltd., Ord. ..	5	6 — [illegible]
£50,000	Stk	4%	Do. 4% Debenture Stk. Red.	100	100 —102
£84,700	100	4½%	Royal Elec. Co. (of Montreal) 4½% 20-yr. 1st Mort. Deb	100	100 —103
40,000	5	5/	St. James' & Pall Mall Elec. Light Co., Ltd. Ord.	5	12¾— 13
20,000	5	3/6	Do. 7% Pref...	5	8 — [illegible]
£150,000	Stk	3½	Do. 3½% Deben. Stock, Red	100	98 —101
12,000	5	4/-	Smithfield Markets Elec. Supply Co., Ltd. Ord.	5	2 — 2½
£50,000	Stk	4%	Do. 4% Debenture Stk. Red.	100	76 — 80
65,000	5	4/-	South London Elec. Sup. Co., Ltd. O.	5	3 — 3½
100,000	1	—	South Metropolitan Elec Light & Power Co., Ltd. Ord.	1	[illegible]
50,000	1	8½d.	Do. 7% Cum. Pref.	1	1⅛ —1¼
£100,000	Stk	4½%	Do. 4½% 1st Deb. Stock Red.	100	105 —108
50,000	5	2/6	Urban Electric Supply Co., Ltd., O.	5	4½ — 4¾
30,000	5	2/6	Do. 5% Cum Pref.	5*	5 — 5½
£200,000	Stk	4½	Do. 4½% 1st Mort. Deb. Stk. Red	100	104 —106
110,000	5	6/6	Westminster Elec. Supply Corp. Ltd., Ord.	5	11½—12
28,151	5	2/6	Do. 5% Cum. Pref.	5	5¾ — 6½

V.—TELEGRAPH & TELEPHONE COMPANIES.

Present Amount Subscribed	Shares	Last Dividend	Name	Paid up	Closing Prices
£34,800	100	4	African Direct Tel. Co., Ld., 4% Mt. Debs. (Series A), Red.	100	99 —102
25,000	10		Amazon Telegraph Co., Ld... ..	10	[illegible]— 4½
£763,580	Stk	14/-	Anglo-American Tel. Co., Ltd., Ord.	100	61 — 63
£3,118,210	Stk	[illegible]	Do. 6% Preferred Ordinary	100	109 — 110
£3,118,210	Stk	2/-	Do. Deferred Ordinary ..	100	16½ - 17½
44,000	5	5/	Chili Telephone Co., Ltd.	5	7¾ — 8
$15,000,000	$100	$2	Commercial Cable Co., Capital Stk.	$100	—
£1,903,856	Stk	4%	Do. Sterl. 500-yr 4% Deb. Stk., Red.	100	96½ - 98½
16,000	10	5/-	Cuba Submarine Tel. Co., Ld., Ord.	10	8½ — 9
6,000	10	10/-	Do. 10% Preference .. .	10	17 —18
6,000	5	2/-	Direct Spanish Telegraph Co., Ord.	5	3¼ - 3½
		5/-	10% Cum. Preference	5	8 — 9½
£30,000	50	4½%	Do. 4½% Debs...	50	100-103%
60,710	20	4/-	Direct U.S. Cable Co., Ltd... ..	20	14 — 15
£85,800	100	4½%	Direct West India Cable Co., Ltd., 4½% Reg. Debs.	100	101 — 103
£300,000	100	4%	East. & S. African, Ld., 4% Mt. Dbs.	100	100—102
£200,000	25	4%	Do. 4% Rg. Mt. Dbs. (Mauritius Subsidy)..	25	100 — 102
300,000	10	2/6	Eastern Extension, Australasia and China, Ltd...	10	14½ -15
£602,400	Stk	4%	Do. 4% Mort. Deb. Stk., Perp.	100	106 - 108
£4,000,000	Stk	25/-	Eastern Tele. Co., Ltd., Ord. ..	100	144 - 147
£2,000,000	Stk	17/6	Do. 3½% Pref.	100	90 - 92
£1,836,814	Stk	4%	Do. 4% Mort. Deb.	100	106 —108
150,000	10	5/-	Great Northern Telegraph Co., Ltd., (of Copenhagen) ..	10	36½ — 38½
£58,700	100	4½%	Halifax and Bermudas Cable Co., Ltd., 4½% 1st. Mort. Debs. Red.	100	101 —103
17,000	25	12/6	Indo-European Tele. Co., Ltd. ..	25	57 —59
£251,127	1		Marconi's Wireless Tel. Co, Ltd. ..	1	1⅛ — 1[illegible]
72,080	1	6d.	Monte Video Telephone Co., Ltd., O.	1	⅞— 1
£1,988,338	Stk	6%	National Telephone Co., Ltd., Pref.	100	110½ — 111½
£1,966 667	Stk	5%	Do. Deferred	100	108 —110
250,000	5	2/6	Do. 5% Non-Cum. 3rd Pref.	5	5⅛ — [illegible]
£2,000,000	Stk	3½%	Do. 3½% Deb. Stk., Red. ..	100	98½ —100
£689,598	Stk	4%	Do. 4% do. do. ..	100	104 —106
179,313	1	7½d.	Oriental Telephone & Elec. Co., Ltd.	1	1¼ — 1[illegible]
50,000	1	7½d.	Do. 6% Cum. Pref.	1	1¼ — 1½
£100,000	100	4%	Pacific & European Tel. 4% Guar. Debs. Red...	100	100—103
11,839	8	4/-	Reuter's Telegram Co., Ltd. ..	8	7¼ — 7¾
58,000	5	3/-	United River Plate Telep. Co., Ltd.	5	7½— 8
40,000	5	2/6	Do. 5% Cum. Pref.	5	5½ — 5¾
£179,947	Stk	5%	Do. 5% Deb. Stock, Red. ..	100	111 —113
15,609	10	4/-	W. African Telegraph Co., Ltd. ..	10	9½ — 10
£30,008	2½		West Coast of America, Ltd. ..	2½	[illegible]
150,000	100	4%	Do. 4% Deb. Guar. by West. Tel.	100	100½ - 102½

TELEGRAPHS AND TELEPHONES.—*Contd*

Present Amount Subscribed	Shares	Last Dividend	Name	Paid up	Closing Prices
88,321	10	6d.	W. India & Panama Teleg. Co., Ld., Or.	10	½ — ¾
34,563	10	6/-	Do. 6% Cum. 1st. Pref. ..	10	8¼— 8¾
[illegible]	10	6/-	Do. 6% Cum. 2nd Pref. ..	10	6½ — 7½
£80,000	100	5%	Do. 5% Deb.	100	101 —104
207,330	10	3/-	Western Telegraph Co., Ltd. ..	10	13¾—14¼
£75,000	100	5%	Do. 5% Debs., 2nd Series, 1906	100	102 —104
[illegible]	Stk	4%	Do. 4% Deb. Stock, Red. ..	100	103½—105½

VI.—SHIPPING COMPANIES.

Present Amount Subscribed	Shares.	Last Dividend.	Name.	Paid up	Closing Prices
32,500	10	5/6	Anchor Line (Henderson Bros.), Ltd., 5½% Cum. Pref.	10	9¼— 9¾
£325,000	Stk	4½%	Do. 4½% Red. 1st Mort. Deb. Stk.	100	100—102
£672,900	Stk	4½%	British & African Stm. Nav. (1900) Ltd., 4½% 1st Mort. Deb. Stk., Red.	100	99 —101
40,000	10	5/6	Bucknall Steamship Lines, Ltd., 5½% Cum. Pref.	10	6¼—
£600,000	Stk	4½%	Do. 4½% 1st Mort. Deb. Stk.	100	— —
£750,000	Stk	4½%	Clan Line Steamers, Ltd., 4½% Deb. Stk. Red. ..	100	99 —101
60,000	20	16/-	Cunard Steam Ship Co., Ltd., Nos. 1-60,000..	20	13¼ — 13¾
40,000	20	8/-	Do. Nos. 60,001-100,000	10	5¼— 6½
£464,430	Stk	4½%	Elder Dempster Shipping, Ltd., 4½% 1st Mort. Deb. Stk. ..	100	102—104
1,200,000	1	6d.	Furness, Withy & Co., Ltd., Ord...	1	1½ — 1⅝
25,328	7½	4/7	Gen. Steam Navigation Co., Ld., Ord.	7½	5 — 5½
36,758	8	4/9¾	Do. Non-Cum. 6% Pref.	8	8¾— 9¼
£150,000	Stk	4%	Do. 4% 1st Mort. Deb. Stk. Red.	100	98 —100
55,000	5	1/3	Houlder Line, Ltd., Ord.	5	1 — 2
40,000	5	2/9	Do. 5½% Cum. Pref.	5	2¼— 3¼
£200,000	Stk	4½%	Do. 4½% 1st Mt. Deb. Stk. Red.	100	87 — 90
141,500	10	5/-	Leyland (Fredk.), & Co., (1900), Ltd., 5% Cum. Pref. ..	10	5½— 6
20,349	10	5/-	Orient Stm. Nav. Co., Ltd., Pref Nos. 1-20,349 ..	10	7 —7½
£103,100	Stk	4%	Do. 4% Deb. Stk., Red.	100	89—92
£1,160,000	Stk	5%	Peninsular and Oriental Steam Nav. Co., 5% Cum. Pref. ..	100	125 -128*
£1,160,000	Stk	19%	Do. do. Deferred ..	100	238 -241*
15,000	100	30/-	Royal Mail Steam Packet Co. Ord..	60	46— 47
39,075	5	2/6	Shaw, Savill & Albion, Ltd., 5% Cum. "A" Pref..	5	4¾ — 5¼
39,075	5	2/6	Do. "B" Ord...	5	3¾— 4¼
141,841	10	4/-	Union Castle Mail Steamship Co., Ltd., Ord..	10	8½— 9
24,000	10	4/6	Do. 4½% Cum. Pref... ..	10	10¾ — 11¼
£1,008,894	Stk	4%	Do. 4% Debenture Stk., Red.	100	101 —103

VII.—MISCELLANEOUS COMPANIES.

Present Amount Subscribed	Shares.	Last Dividend.	Name	Paid up.	Closing Prices
60,000	1	9⅜d.	Chadburn's (Ship) Tele. Ltd., Ord...	1	[illegible] —1¼
£750,000	Stk	5%	General Hydraulic Power Co., Ltd.	100	123 —128
12,500	10	10/	Oakey (John) and Sons, Ltd., Ord..	10	26 — 28
10,000	10	6/-	Do. do. 6% Cum. Pf	10	14 — 15
183,538	1	6·3d.	Power Gas Corp., Ltd., Ord., Nos. 66,463-250	15/-	¼ —
66,462	1	8·4d.	Do. do. Nos. 1-66,462	1	⅜— ½
135,000	1	6d.	Waygood (R.) & Co., Ltd., Ord. ..	1	1⅛ —1[illegible]
135,000	1	7½d.	Do. 6% Cum. Pref. ...	1	1⅜—1½

RAILWAY CARRIAGE & WAGON COMPANIES.

Present Amount Subscribed.	Shares.	Last Dividend	Name	Paid up.	Closing Prices
10,000	10	7/6	Birm. Railway-Car. & Wagon, L., 1-10,000	10	25 — 2[illegible]
8,739	10	3/-	Do. Second Issue 1-8,739....	4	9¾—10
10,000	10	6/-	Do. Cum. Pref. 6% 1-10,000..	10	13 —14½
30,111	7	7/-	Gloucester Rail.-Car & Wagon, Ld., A, 1-29,861 & 49,751-50,000	7	10½— 10¾
44,889	7	3/6	Do. B, 29,862-49,750, 50,001-75,000	7	4½— 4¾
14,567	10	1/3	Lancashire Wagon, Ord.	2	2¼— 2¾
4,150	10	5%	Do. do.	10	10⅜—10⅝
784,808	1	9d.	Metropolitan Amalgamated Rail.-Carriage & Wagon, Ld., 1-784,808	1	42/9 43/9
164,288	1	6d.	Do. Cum. A Pref. 5% 1-164,288	1	24 —25
235,000	1	7½d.	Do. Cum. B Pref. 6% 1-235,000	1	28/ —29/
20,000	20	20/-	Midland Rail.-Car & Wagon, Ld., 1-20,000	10	20½ — 21½

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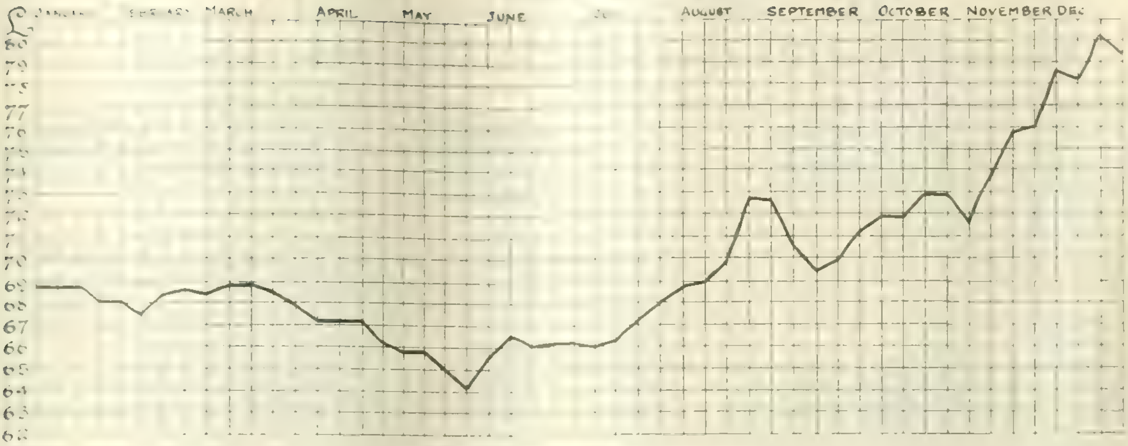


COPPER.

Based upon the [illegible] price of each week.

THE METAL MARKET.

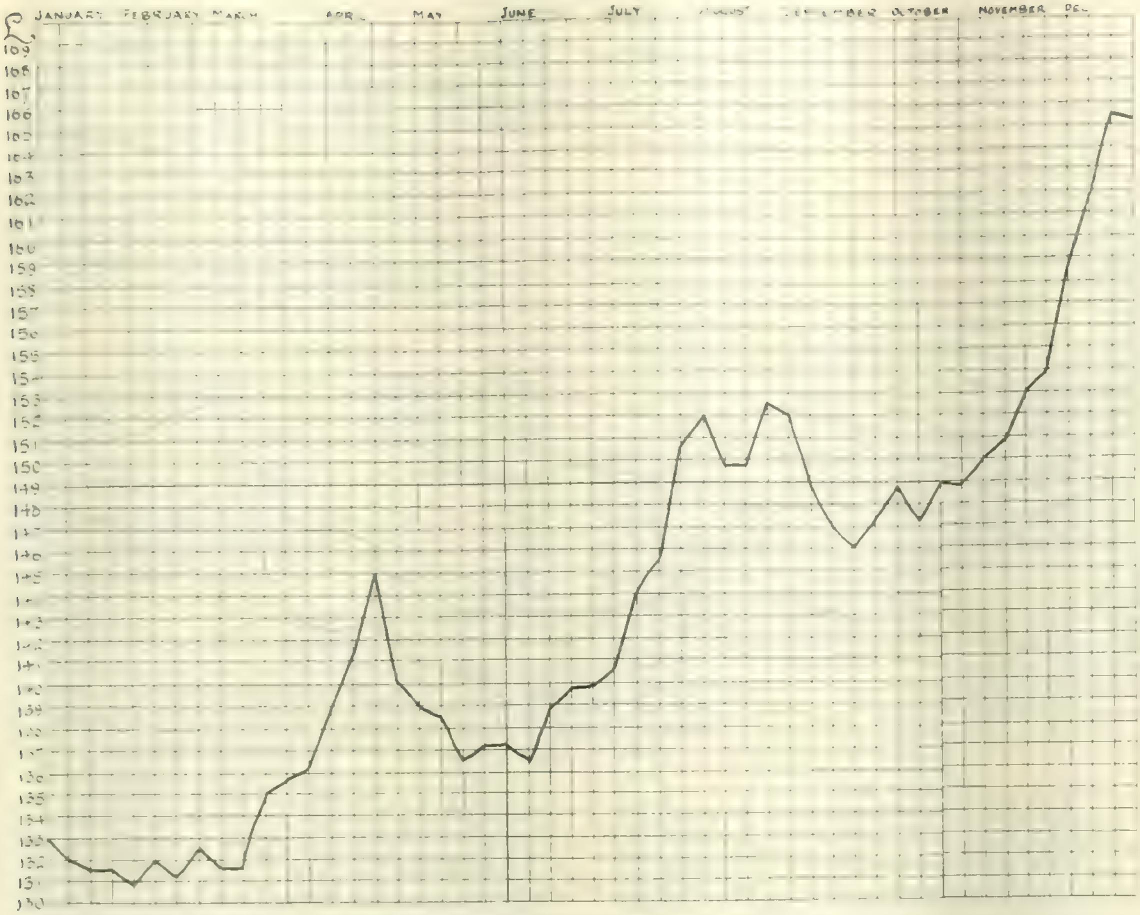
PRICES IN 1905.

COPPER.

THE past year, as an examination of our chart [illegible] clearly shows, has been an eventful [illegible] the copper market. In the review of the metal markets, published a year ago, the fact was recorded that a strong bull movement had been initiated in the closing weeks of the year which put copper to the highest price touched during the year 1904. That movement lasted but a short period, and from the highest price, £69, there was a gradual decline to the neighbourhood of £64, which suggested that the predicted rise in copper was indefinitely postponed. Increase of consumption, however, produced a sudden change in the market, and it was soon evident that consumers had allowed their stocks to fall to a dangerously low level. Under the circumstances, it was not surprising that, when copper was at £64, those who required large quantities of the metal for manufacturing purposes, should take advantage of the opportunity to cover their requirements. This process forced the quotation of the metal up to the then high-water mark of £72 15s., a price which, as the chart records, was reached at the end of August. From that date, with but one break, the course of the market has been steadily upwards, and at the time of writing copper has reached the price of about £80, or £11 in excess of the closing price of 1904. The upward movement in the metal market has been associated with an outburst of rampant speculation in [illegible] Wall-street. Anacondas [illegible] phenomenal rise this week.

Looking ahead, it is somewhat difficult to see what is to prevent a further rise in the price of the metal. The position is still as strong as ever, with a continued good demand, and no sign of falling off in consumption. The metal appears to be very scarce up to April, and it is reported, moreover, that consumers have already been buying heavily for May delivery. It may be fairly said, indeed, that the dearth of copper has reached the acute stage. Happily, the famine is likely to be relieved in the not distant future by the arrival of additional supplies from China and Japan. Large sales of Japanese copper continue to be made to Europe for delivery in three and six months' time, and larger shipments may also be expected from the United States, on the understanding that no more copper is likely to be shipped to China for some little time to come. It has to be borne in mind also that should copper maintain its present price for more than a short period, consumption will fall off in some directions, notably in the manufacture of sulphate of copper, and, of course, it is obvious enough that the present high value of the metal will stimulate production. That being so, the predictions made in some quarters that copper will see a price of £100 per ton during the next few months may be disregarded. Copper will no doubt be dear and scarce for some little time to come, but from the causes indicated above, the market will eventually find the necessary relief, when copper will return to a lower range of values.

TIN.



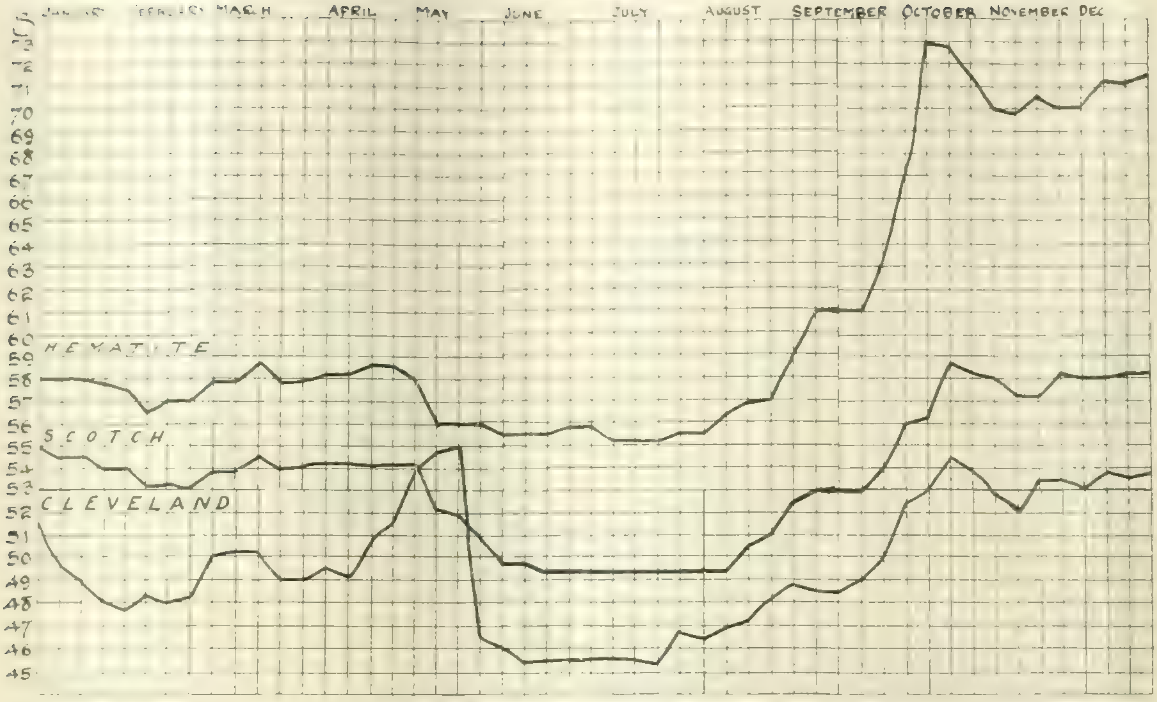
Based upon maximum price of each week.

TIN.

The pr[illegible] when reviewing the prospects of the [illegible] would reach a higher level, has been amply verified. Tin has risen from an opening price of £133 to £162, and this abnormal improvement in values has been associated with somewhat sensational developments in the market. During the early weeks of the year the course of dealings gave little or no indication of subsequent developments, and when £132 was realised at the January Banca sale it was considered that a good sale had been effected. Even at this early period, however, there were indications of unwillingness on the part of holders to make any substantial offerings, and the statistical position at the beginning of March suggested an early rise in the price of the metal.

In April the fear of abnormal prices for the metal overhung the market. The price had then risen to £139, and it was reported that in Holland the market was practically bare of spot tin. The bull element took temporary control of the position, with the result that there was a sharp bear squeeze, and the price was run up to £145. Thereafter, the course of the market was still upwards. In the middle of July the expected increase in the demand began to reveal itself, and a jump in quotations carried the price to £149, and by the beginning of August the rise had become sensational, the price having improved to £152. At this figure there was a certain amount of realisation on the part of weak holders, and there was a temporary [illegible] It was evident, however, that the bull element never lost its hold of the position, and any attempt to depress prices was followed by a sharp rally. Arrivals from the East continued small, and the limited supplies of spot metal were well controlled, so that September saw the beginning of the movement which has continued down to the present time, and which has carried the metal to the

PIG IRON.



Based upon [illegible] price of each week.

abnormally high price of £165 10s., shown in the chart. As to the future, it is difficult to speak with much confidence. The bull position appears to be thoroughly sound, and a fresh upward movement would surprise no one conversant with the situation.

IRON.

Curious developments have been witnessed in the iron market during the present year. Two facts strike the observer, that, while more iron has been produced than ever before, more has also gone into stock, so that the consumption has been less. Indeed, the extent of the visible supplies is a remarkable feature, and, although the final statistics for the year are not yet available, it is probable that the increase in the quantity in public stores will at the end of the year be something like 600,000 tons over that at the end of 1904. The total production of pig-iron has been about 3,300,000 tons. The feature of the position on which attention will be focussed is, that while the stock of Cleveland is the largest on record, the price of warrants has been maintained at a comparatively high level.

In one respect the position has latterly somewhat improved, for, while the large stock of Cleveland was originally in very few hands, the holding is now fairly well distributed. The chief reason which has induced those outside the inner ring to buy Cleveland warrants has been the belief that exigencies in American trade would necessitate exports, and it is suggested by the Statist that a portion of our large stocks is held on behalf of American holders as a hedge against a further rise of prices in the United States. At the time when it became evident, in May last, that there was a decided corner in Cleveland it was imagined that the closing of that corner and the release of this large quantity of iron would cause a break in prices. As a matter of fact, nothing of the kind occurred. Cleveland went back to its normal level of 45s., and, in spite of the fact that the stock has been growing larger week by week since that time, the close of the year sees Cleveland at over 53s. This is a very tempting price, and it is not surprising that smelters go on making iron and sending it into store. The position, it will be seen, is to a great extent artificial.

This is not the case with Hematite, the rise in the price of which is mainly accounted for by the activity in shipbuilding. In addition, the supply of Hematite ore available is a strictly limited quantity, and the freight question is a factor which has to be taken into consideration. As to the future, it has been suggested that there will be exports of Cleveland foundry iron both to Germany and America, but we regard this as somewhat improbable.

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26,018. J. B. WALSH, Manchester.—Improvements in smoke-consuming devices for steam generator and like furnaces.

26,029. A. BELLAIR, Paris.—Improvements in and relating to chain-welding machines.

26,032. J. J. H. STURMEY, Coventry.—Improvements in or relating to electric ignition systems for internal combustion engines.

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26,036. THE ELECTRIC AND ORDNANCE ACCESSORIES COMPANY, LTD., R. HANCOCK, and R. F. HALL, Birmingham.—Improvements in fans of the rotary propeller type.

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[illegible] THE FRODINGHAM IRON AND STEEL COMPANY, LTD., and M. MANNABERG, London.—An improvement in blast furnaces.

RECENT SPECIFICATIONS.

T. M. Anderson, and R. Wormald, Oldham. Lancashire. [illegible] Relates to rolling metals. In a machine for rolling nut blanks rolls *g*, *h*, fig. 1, one or both of which may have studs *p* on the periphery, are mounted in a frame and driven by spur wheel gearing. The [illegible] of the rolls are

FIG 6.

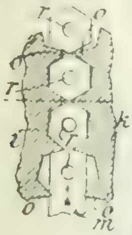
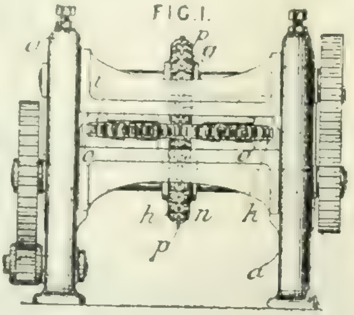


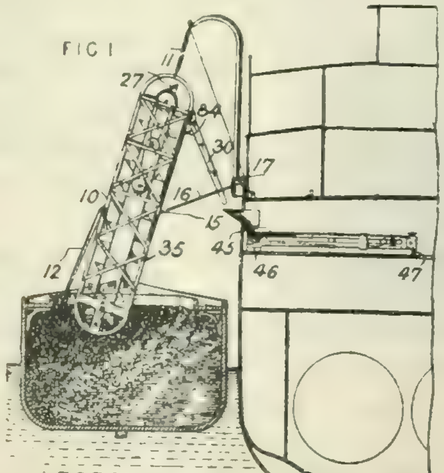
FIG. 1.



provided with recesses [illegible] which mesh with projections *o* on two horizontal rolls *i*, *k*. In passing the heated bar *m*, fig. 6, through the rolls, the projections *n* form the indentations on the bar and the studs *p* form the holes *r* in the blanks.

L. A. de Mayo, New York, U.S.A.—18,509, August 20th, 1904. Relates to coaling ships. The apparatus consists of elevator and conveyor for putting coal in at the coal ports of a vessel and distributing or trimming it to the bunkers. Fig 1 shows the apparatus at work. The elevator [illegible] adjustably suspended at the side of the vessel, takes coal from the lighter and delivers it [illegible] to the hopper 45 of [illegible] endless-band conveyor, which is movable on a rail 47 [illegible] delivers into the different bunkers. [illegible] adjustable supports for the elevator [illegible] ladders 12 and 16 [illegible] hooked over the rail 17 and connected at their other ends to sleeves 15 sliding on guide-rods on the elevator. The elevator chain consists of plates hinged together and having triangular brackets 27 secured to some of the plates. The coal is delivered to the shoot 30 over the back of the bucket adjacent thereto, and any coal that may escape is caught by a shield 35 extending down the inner side of the elevator and returned to the lighter. The shoot 30 consists of telescopic sections connected by hinged yokes, and it is supported by an adjustable brace 34. The conveyor frame is telescopic and fitted with self-adjusting rollers to keep the tension constant. The elevator and the distributor are preferably driven by motors mounted in their frames.

FIG I



A. Bauermeister, 1, Avenue Reille, Paris.—18,507, August 22nd, 1904.—Relates to steam turbines. Figs. 1 and 2 show respectively a longitudinal and a cross-section of a steam turbine. The distributors *f*, *g* are formed in rings and joined together so that the vanes [illegible] on the discs [illegible] of the drum *b*, can revolve between them. In the section shown in fig. 1 the [illegible] distributing channels *r*, *h*, are arranged eccentrically to the outer walls to allow for the uniform expansion of the steam. The inner distributor *g* may be dispensed with, as shown in fig. 3.

FIG 1.

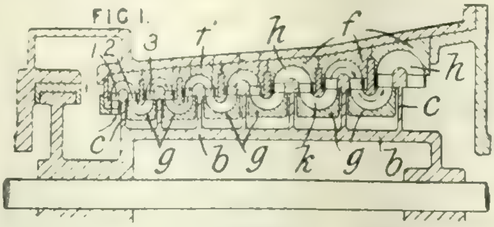


FIG. 3.

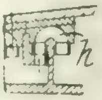
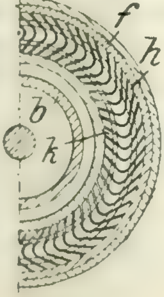


FIG. 2.



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As its title indicates, this volume is another addition [illegible] large number of works on elementary [illegible]ering. The author explains that [illegible] gives the substance of the lect[illegible] [illegible] to young artisans attending an evening continuation school. It is profusely illustrated, a number of the drawings are from actual machines and apparatus in current use; many others have been drawn [illegible] to illustrate the principles upon which the apparatus represented depends for its action, while the characteristic curve figures given are reproduced from personal tests carried out by the author. As a class book its practical utility would have been enhanced if the diagrams had been reproduced on a larger scale.

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Mr. Joseph Horner's industry is remarkable; the rate at which he launches new works, or new editions can only be compared with that of a successful n[illegible] [illegible] not that his books are by any means works of imagination, for we have previously called attention to some of their sterling qualities, but his name seems to [illegible] so often that we can only regard his energy as indefatigable. The present publication, he informs us, is "intended to cover the entire practice of civil and mechanical engineering." The project is a gigantic one, and so far as we are aware, one that has yet never been accomplished; but, judging by the two volumes now ready, if the editor keeps the succeeding parts up to the standard of the first, he may anticipate a fair degree of success. Mr. Horner summarily rejects "borrowed catalogue blocks," and promises that all the illustrations will be reproduced from original photographs, or from drawings specially prepared under his supervision. A prominent characteristic of the work is the attention given to the processes of the various trades included in engineering construction; the articles are from the pens of practical men, lucidly written, and designed to be of actual use by the foundryman, moulder, patternmaker, or smith. The draughtsman will be able to study shop processes, while the craftsman can become acquainted with the principles of the design of the mechanisms constructed. Students of technical colleges, to whom the acquisition of knowledge of shop practice is of primary importance, should find in the Encyclopædia answers to the many questions which crop up daily in the course of their training. Although planned to be a work of reference mainly for practical men, the theoretical side has not been neglected, and [illegible] the thermodynamics of steam [illegible] been treated mathematically. The arrangement of the work precludes long articles, and instead of dealing with engines, lathes, or machine tools in comprehensive articles, a general survey only of the subject is included under these heads. For detailed information [illegible] must [illegible] to special entries such as [illegible] planing machine, etc.

CATALOGUES, ETC.

Ed. Bennis and Co., Ltd.—Two interesting illustrated pamphlets of value to those who are desirous of effecting boiler-house economies, have been issued by the above firm. One of these describes the modern coal and ash handling plant at the Grimethorpe, Frickley, and Carlton Main Collieries, the other is concerned with the coal-conveying plant constructed by the firm at Acton Lane, for the Metropolitan Electric Supply Company.

Quaker City Rubber Company.—A subject of great practical utility is discussed in a new pamphlet issued by the above company, dealing with Daniel's P.P.P. rod packing. The gist of the matter is put into rubrics—an excellent idea. Many of our readers are already familiar with this invention. The firm claim to be able to save a large amount of the power wasted in overcoming rod friction, and proceed to explain that Daniel's P.P.P. rod packing is composed of two wedges and a cushion, upon which the steam or other fluid, leaking through the neck-bush, and pressing upon the base of the inner wedge, produces a vertical and also lateral motion, sliding that particular wedge against its fellow, and therefore on to the rod. The theory involved will be at once apparent to any engineer, and as a principle has long been established. Several attenpts indeed have been made to put the idea into practice, with more or less indifferent results. Daniel's P.P.P. is built up, and so constructed and prepared, that it always remains sufficiently pliable to permit of expansion and contraction, whether under pressure from the steam or freed from its influence. It is self-setting. It only works on part of the one stroke of an engine, and rests on the return stroke. This is why it saves wear and tear on the rod, and on itself. A booklet, entitled "What Daniel's P.P.P. Packing is, and How to Use It," is also published.

Other Catalogues and pamphlets, etc., relate to: The "Lytestrong" patent pressed steel split pulley by A. Warden and Co., 60, Great Eastern Street, E.C.; Miscellaneous switchboard instruments (No. 188), ammeters, voltmeters, and wattmeters (No. 187), portable electrical measuring instruments (No. 186), and B.T.H. flexible ear for grooved trolley-wire, from the British Thomson-Houston Company, Ltd.; Specimen commercial stamps, etc., from the Rubber Stamp Company, 14, Broad Street Corner, Birmingham; the Pick-Quick coal-cutter (monthly calendar), from Messrs. Mavor and Coulson Ltd., Glasgow; the "Nesbit" electric lamp, from the Edward A. Evans Electric Lamp Company Birmingham; a green show-card giving list of recent contracts, and a large trade mark show-card, 21 in. by 15 in., from the Simplex Steel Conduit Company, Ltd., Birmingham and London; Quick cutting eccentric sawing machines, gate sawing machine, and full automatic circular sawing machine for cutting up brass and copper tubes, bars and sections, from Edward G. Herbert, Ltd., Manchester; admirably printed catalogues of motor launches, marine motors, and commercial motor vehicles, from Messrs. John I Thornycroft and Co., Ltd., Chiswick; electrically driven hauling gears by Messrs. M. B. Wild and Co., Birmingham; pamphlet on two-cycle gas engines (4th edition) from Messrs. Mather and Platt, Manchester; and Iron Fencing and Constructional Ironwork from G. B. Smith and Co., of Glasgow.

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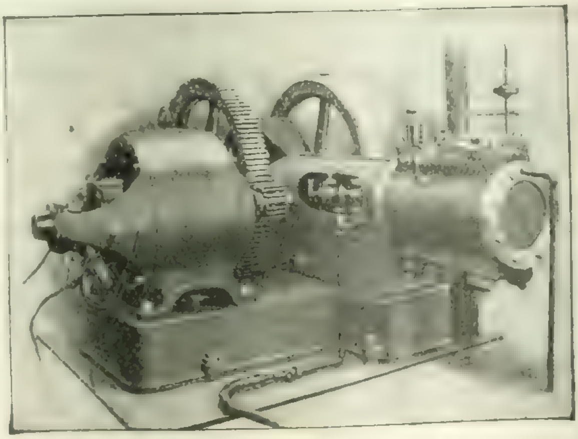

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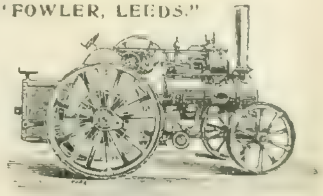

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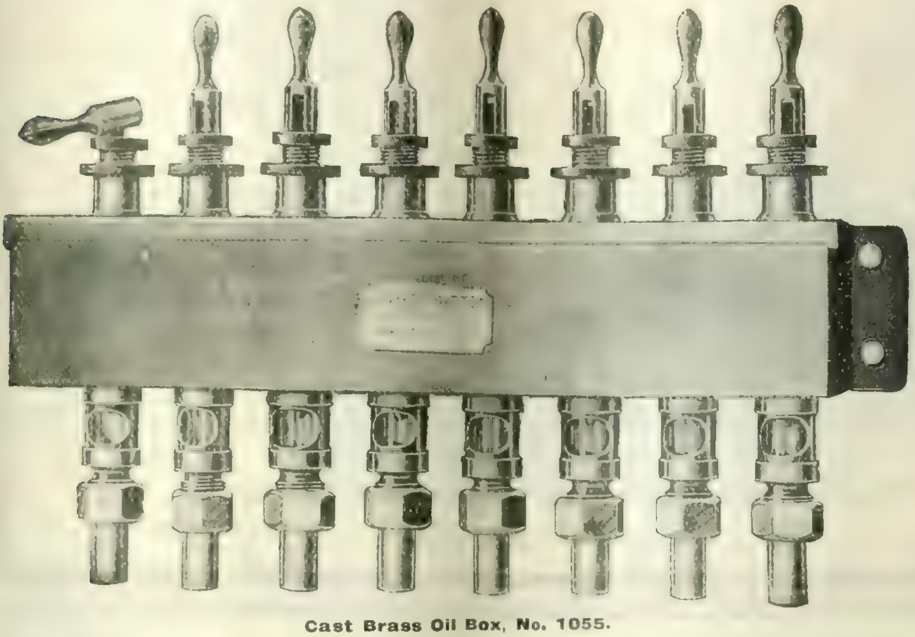

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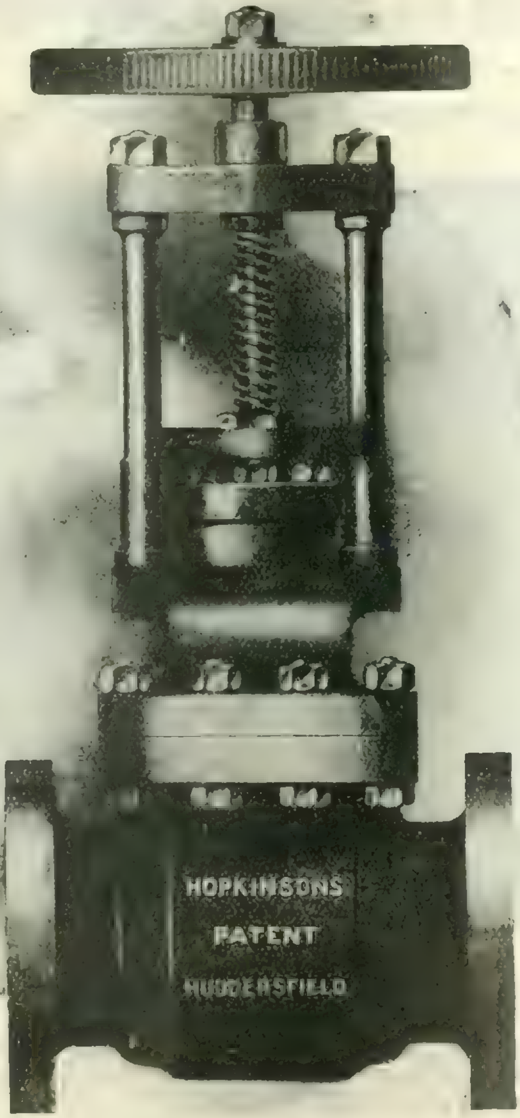

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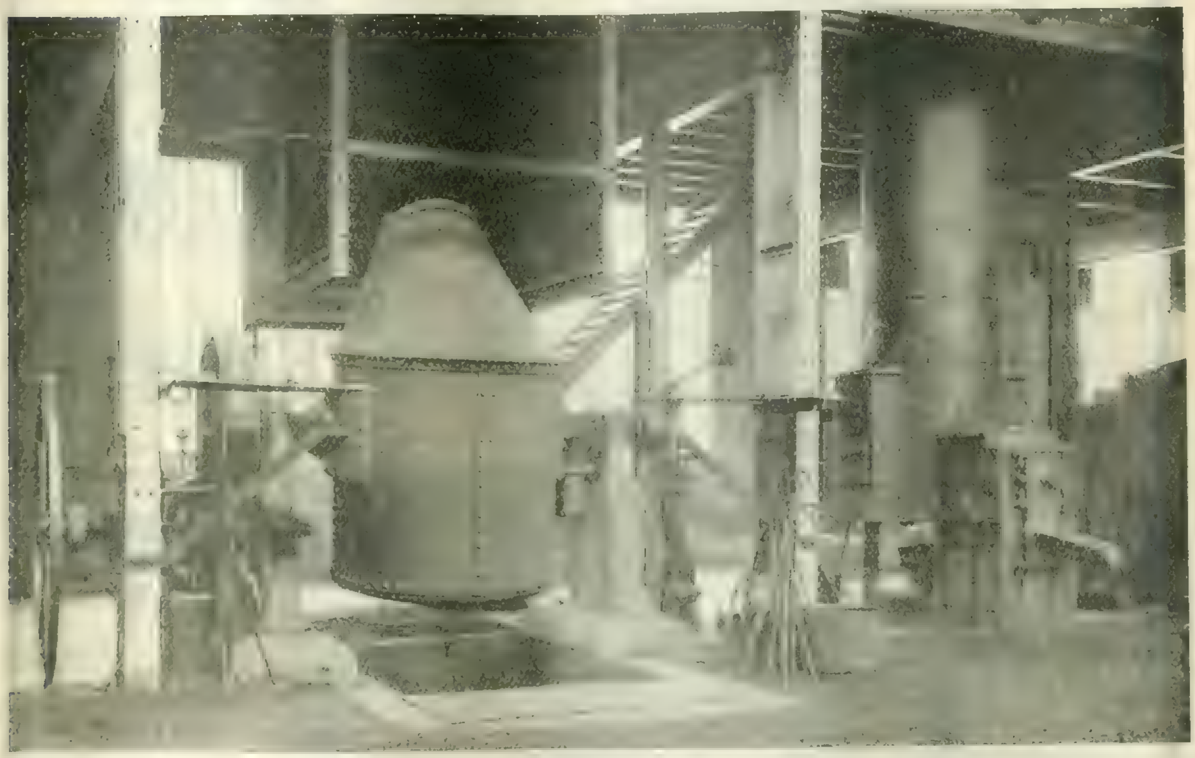

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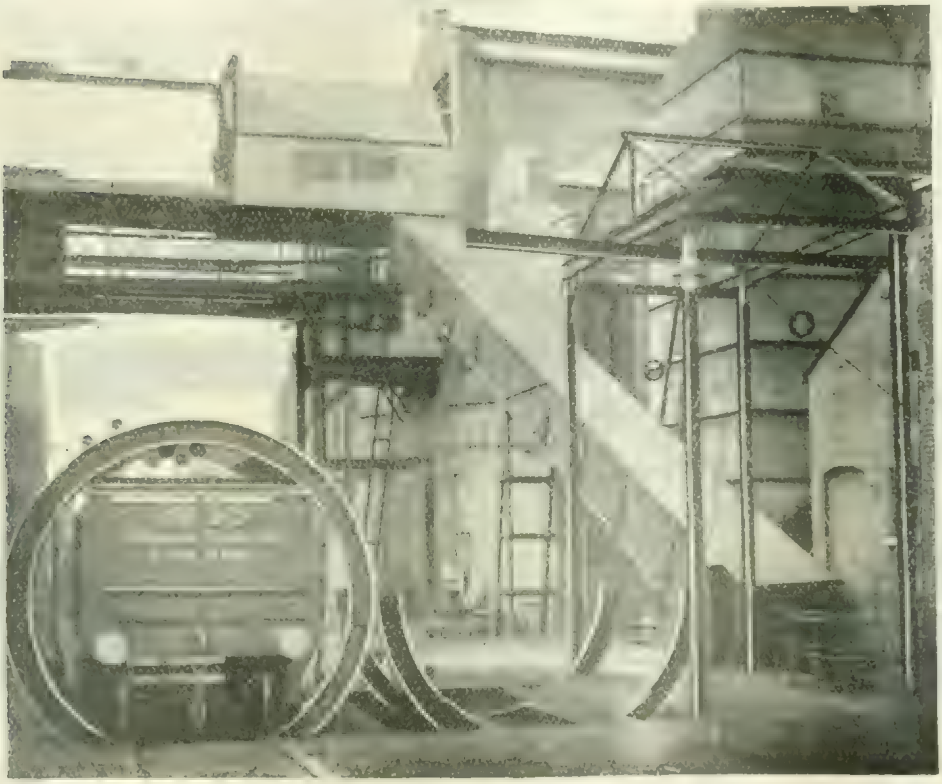

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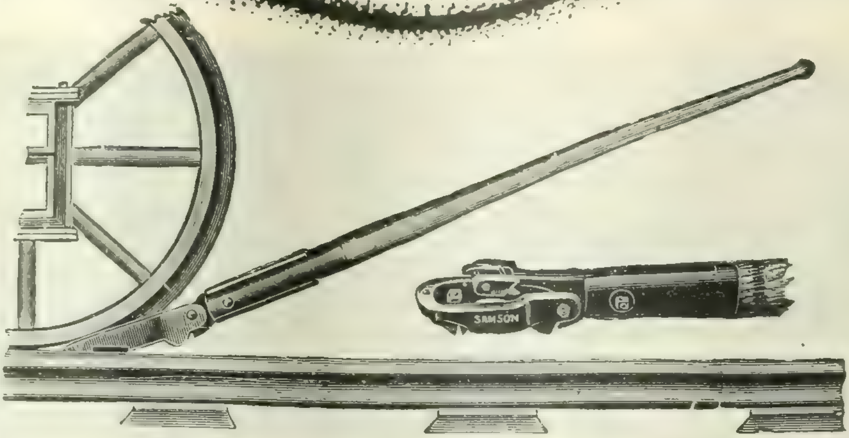

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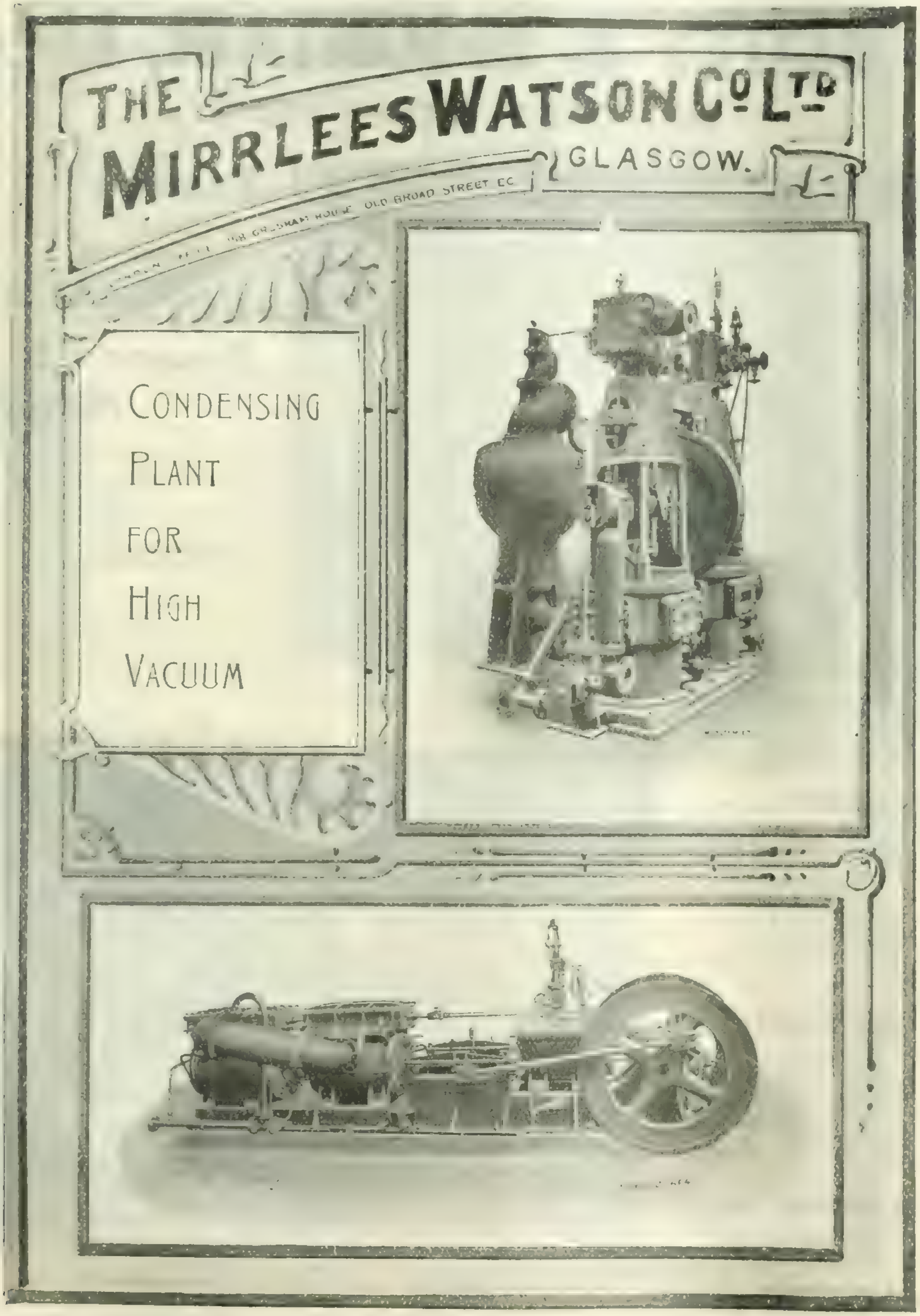

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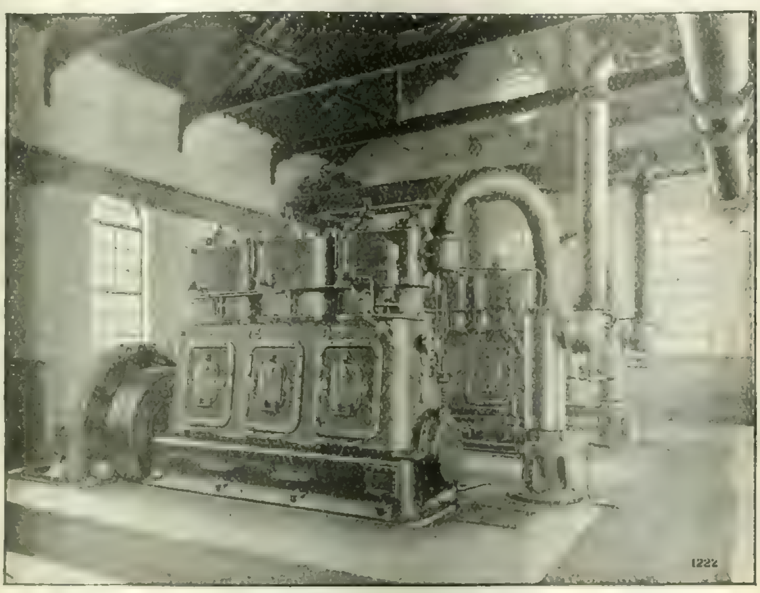

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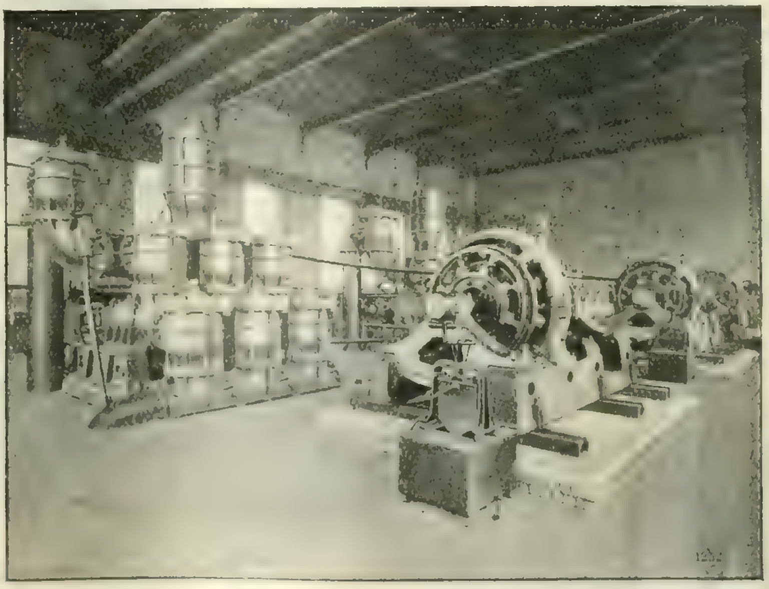

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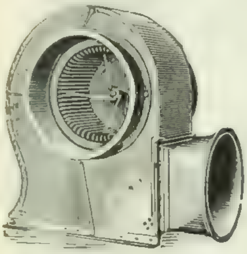

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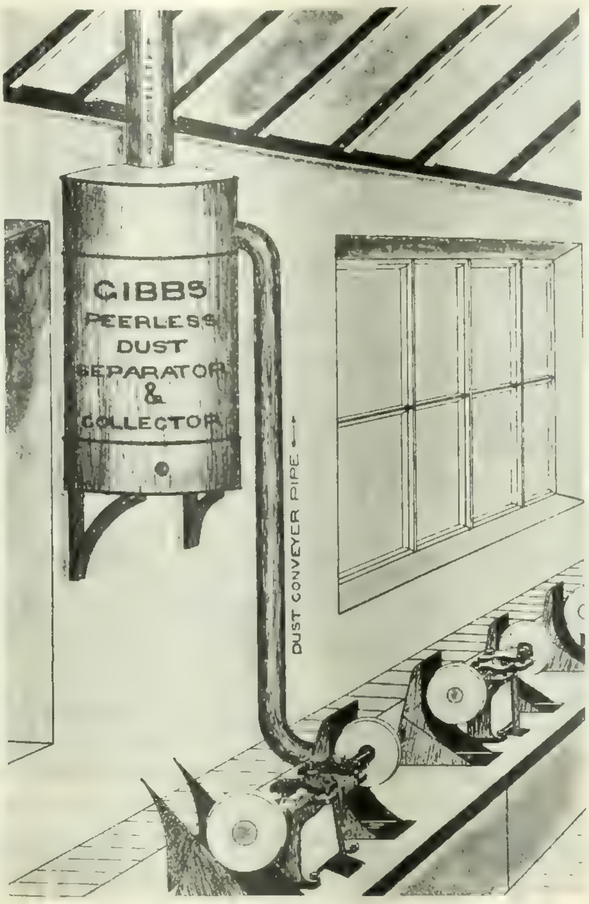
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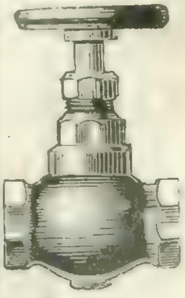

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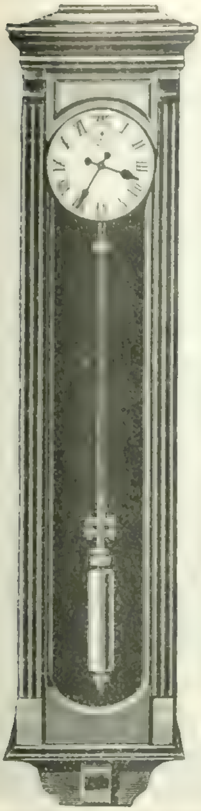

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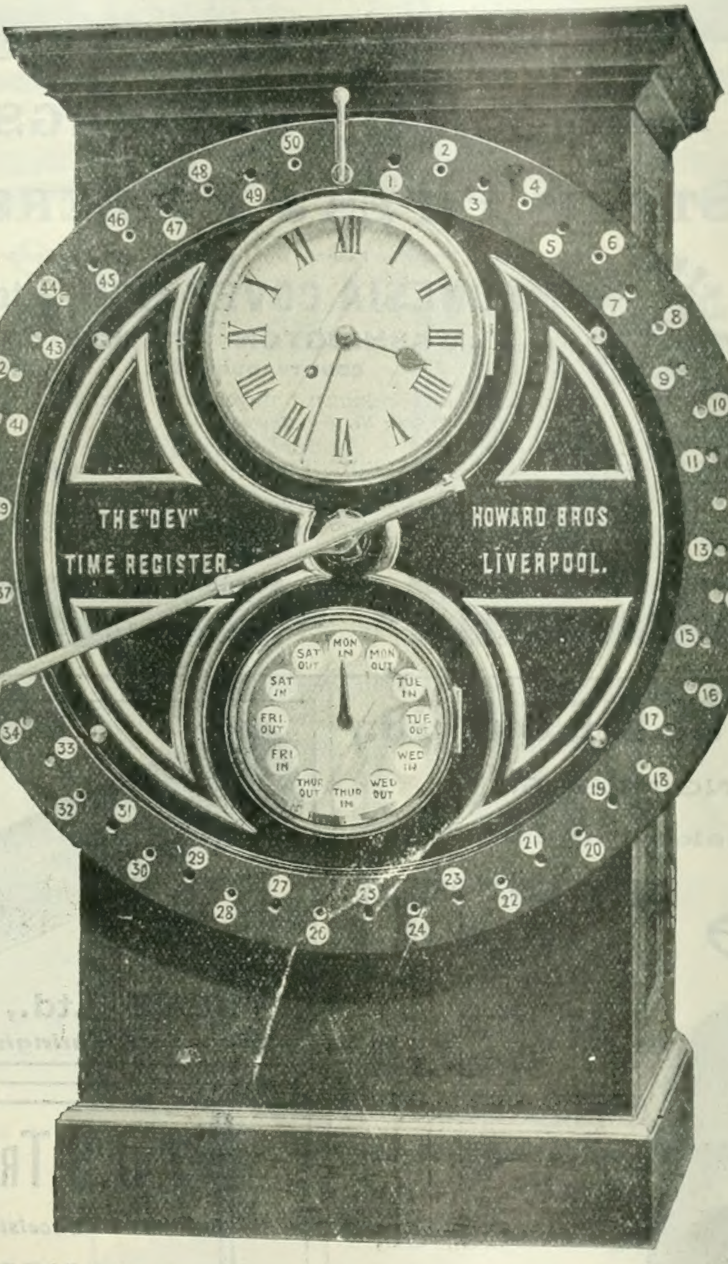

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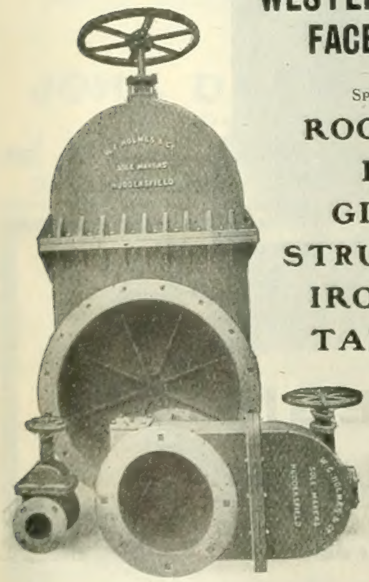

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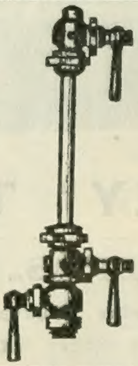

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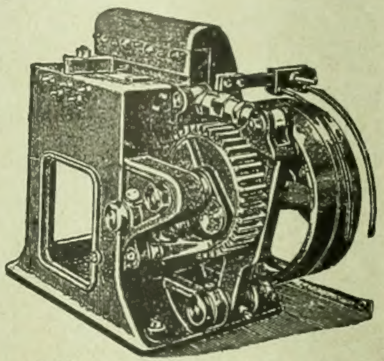

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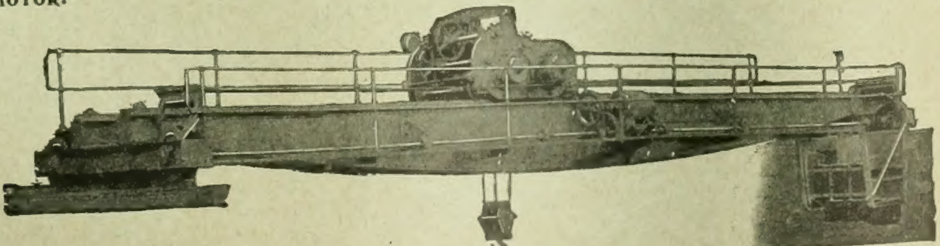

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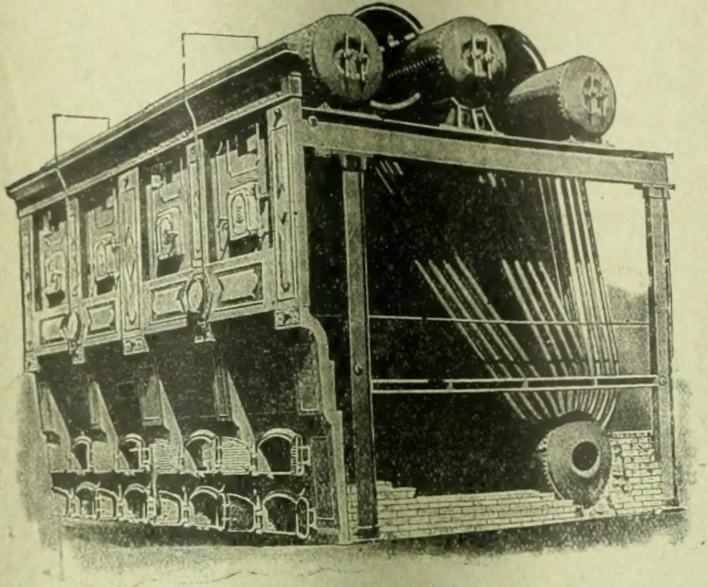

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